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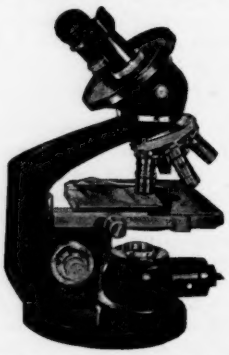

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SCIENTIFIC PAPERS AND SCIENTIFIC LANGUAGE

THE recent report on "Science in the U.S.A. in 1954", issued by the British Commonwealth Scientific Office, North America, directed attention to the interest now being taken in mechanical translation in the United States. A research group at the Massachusetts Institute of Technology is compiling a bibliography on this subject, and one at the Battelle Memorial Institute is seeking to construct a mechanical dictionary which would permit word-by-word or literal translations to be made. The possibility of producing grammatical English translations of selected Russian sentences using an electronic data processing machine has already been demonstrated at the Institute of Languages and Linguistics, Georgetown University; in Great Britain Mr. B. C. Vickery made some comments on the subject in his paper before the Library Association at Southport last September, in discussing the language barrier in science.

More recently, the tenth report of the Nuffield Foundation, in recording the offer of a grant of £7,200 over three years to Birkbeck College, University of London, to support the work carried out by Dr. A. D. Booth, head of the Computational Laboratory there, on mechanical translation, indicates the importance attached by the Foundation to the possibilities opened by the digital computer in translation from one language into another.

This project arose out of the work done in recent years on the development of the electronic computing machine at Birkbeck College under Prof. J. D. Bernal. When this project was first considered, attempts were made to use only those words which can be found in a dictionary; but it has since been found more practical and effective to separate the dictionary into two parts, one for stems and the other for endings, thus bringing the dictionary storage space required well within the capacity of the machine. A preliminary survey indicated that if some one thousand stems and the same number of endings are available, and if these are so chosen as to relate to one special subject, such as biophysics, X-ray crystallography, plant genetics or neurosurgery, addition of about a thousand words of common parlance will enable the machine to translate more than ninety per cent of the texts presented to it.

Here word-for-word translation is unsatisfactory, however, and to solve the problem of word-order, the grammatical structure of the language must be investigated in detail and micro-glossaries—stem-ending dictionaries in the specific subject—must be compiled and coded. Investigation of the adaptability of the machine to tabulate alternative meanings, and the possibility of achieving a literary quality in the end-product has already led to a satisfactory way of handling idioms being evolved. Although it requires a larger storage capacity than is at present available, Dr. Booth is optimistic that even the problems of machine-translation of literary work may prove less complex than they at present appear, and it is expected that the machine will ultimately be able to translate 3,000 words an hour.

How far such developments can be used for dealing with the problem of communication between the scientist and the non-scientist cannot yet be judged; but it is possible that ultimately they could offer some contribution to overcome the difficulty of 'scientific language' which has been the subject of considerable debate since it was discussed by the Parliamentary and Scientific Committee early in November. Meanwhile this research has stimulated work on a further project, that of 'recognition' of texts by the computer, so that it can 'read' or 'take dictation'. For mechanical translation to be useful, the machine must be able to absorb the texts by either sound or sight, otherwise the cost will be prohibitive.

These projects are, however, only one of the ways in which new grants from the Nuffield Foundation during the past year are assisting the solution of problems of human communication. There is at present no organization for collecting and disseminating bibliographical information on the social sciences as a whole and, in particular, on peripheral subjects. To improve the bibliographical organization in this field, which has lagged much behind the development of research in it, the Foundation has made a grant of £2,500 a year for three years in the first place to the International Committee for Social Science Documentation. The National Book League will administer the grant and provide accommodation for the research, the aim of which is to produce good bibliographical tools by elaborating a series of consistent schemes or recipes which will facilitate the provision of abstracts or bibliographies in this field, while keeping duplication to the minimum and ensuring that contributions on peripheral subjects are not overlooked. A survey will be made, in London in the first instance, of the adequacy of the existing library and research facilities for social scientists, and it is hoped that, as a result, similar surveys will be made for other regions.

Such a project, by recording, for example, the location and availability of certain categories of matter, provides a firm basis for co-operation between librarians in improving the resources of their libraries for social scientists. As such it may be said to contribute to the improvement of the marshalling yards and dispersal places of knowledge, if we may adopt the analogy with transport which Mr. R. H. Coats recently used in discussing human communications. On that same analogy, the work on mechanical translation contributes to the improvement of the assembly places of knowledge or the effectiveness of contact with those who wish to use it.

Yet another new grant made by the Nuffield Foundation last year in this field of human communication, which is of special interest to the scientist, is concerned with the medium which is used for

communication. The Foundation has been examining in some detail the best way of assisting the learned journals, many of which are to-day in acute difficulty. Mostly these difficulties are economic, resulting from the sharp rise in the costs of paper, printing, accommodation and staff since the end of the War, while the equivalent general rise in the cost of living makes it very difficult to raise subscriptions to the necessary level. Moreover, the changes proposed in the postal rates for printed matter and parcels in the autumn budget threaten to make the position in 1956 onwards acutely difficult for many learned societies which seek to further the spread of technical or scientific knowledge. The Textile Institute, for example, which already spends more than £20,000 a year on the publication of its *Journal*, will now have to find an additional £1,000 for distribution charges. Nor does the effect end there. Libraries and institutions are equally affected by these higher postal rates, and the sums available for subscription to such periodicals or for the circulation of copies are proportionately diminished.

The Foundation recognizes that the learned periodicals vary enormously in the strength of their endowment, the size of their circulation, and the potential increase of their circulation by use of sound professional methods. Its examination of the publishing and distribution techniques of the learned periodicals has indicated the existence, on the whole, of a conservative attitude towards new printing processes and sales methods. A few have adopted type-photo-offset and similar formats, with an approximate saving of twenty per cent in printing costs. Production economies in size of margin or type, or even quality of paper, have scarcely been considered, and no group of periodicals seems to have examined the economies that might be achieved by bulk-buying of paper or the increased sales which might result from an attractive but still dignified cover. Although the rise in production costs is now less marked, there is little prospect that costs will drop below their present level in the near future. The only hope of narrowing the gap between costs and returns seems to lie in improving the technique of production and sales, and in some measure of centralization of effort.

However strong a case could be made for government assistance to some particular periodical—certainly a strong case could be argued in respect of postal charges on all learned periodicals—that case can scarcely be presented until the possibilities just indicated have been fully explored. It is welcome news, therefore, that the Nuffield Foundation has set aside a sum of £43,750 over five years to be spent on the support of journals in fundamental subjects. The British Academy and the Royal Society have been informed that a sum of £8,000 a year will be available for that purpose during the next five years, and that a further sum up to £750 a year will be set aside for the payment of any professional advisory fees that may be necessary.

The distribution of the grant will be entrusted to two special committees, one for the humanities, appointed by the British Academy, and one, appointed by the Foundation in consultation with the Royal Society, for the scientific periodicals. Each grant will be on a yearly basis, and no periodical will be supported unless, in the opinion of the allocating committee, it is doing all within its power to make its economic position stable or else is prepared to accept and act upon the advice offered by a panel of advisers. This panel will comprise a small number of highly experienced commercial publishers and printers invited to serve by an executive liaison committee, consisting of the Secretary of the British Academy, the Assistant Secretary of the Royal Society, and the Director of the Foundation, which will review, year by year, the distribution of funds between the Royal Society and the British Academy. Mr. Robert Lusty is already carrying out for the Foundation a pilot survey of the publishing and distribution practices of the learned periodicals.

The Nuffield Foundation is thus assisting an attack on this problem of communication of knowledge in three different fields, and the cumulative effect of the several projects may well be considerable, particularly in the light of the climate of opinion revealed at the first International Congress on Documentation of Applied Chemistry in November. At that Conference, Dr. R. S. Cahn, for example, speaking on the role of the professional and learned societies, suggested the reorganization of publishing methods and cuts in costs, along with an attempt to secure greater support from industry and a users' conference, while mechanical methods in documentation generally were summarized by Dr. E. Pietsch, director of the Gmelin Institute. Moreover, the current discussion on scientific language is of fundamental importance, for the full benefit of mechanical aids and modern methods of production and distribution will only be realized as the content of the paper is adapted to its purpose—that is to say, as it is expressed in language which conveys fully and clearly the ideas in the mind of the writer to the particular type of reader he wishes to address.

That lies at the heart of the argument about scientific language. The scientist has a duty to make himself comprehensible to the readers or audience he wishes to address; and the choice of words is a matter of sense, not of arrogance—of choosing the tools appropriate to the job. It should not be confused with the question of education, even if the education which the scientist himself has received or the character of public education generally is involved. But it is worth bearing in mind that the maxim of Bentham which Dicey included more than fifty years ago among the four points he laid down for the expression of thought is still valid: one word for one thing; another word for another thing—this is the whole secret of style. If scientists consistently remembered with this even one of Dicey's own maxims—that arrangement of thought, more than anything else, is the secret of a good style—many of our difficulties in the communication of knowledge would be greatly simplified, and we should be in a stronger position to reap the full advantages from the new developments which the Nuffield Foundation is helping to explore.

SIMON STEVIN—A FOUNDER OF MECHANICS

The Principal Works of Simon Stevin

Edited by Ernst Crone, E. J. Dijksterhuis, R. J. Forbes, M. G. J. Minnaert and A. Pannekoek. Vol. 1: General Introduction; Mechanics. Pp. v+617. (Amsterdam: C. V. Swets and Zeitlinger, 1955.) 52 guilders.

SIMON STEVIN or Stevinus or Stevens, for the name occurs in all three forms, is probably best known to the general student of the history of science from the attention given to his fundamental work on statics in Mach's celebrated history of mechanics. Some index of his importance is that Lenard includes him in the forty-odd biographies that make up his "Grosse Naturforscher". In particular, Stevin is symbolized by the inclined plane surrounded by a closed chain of spheres, with the inscription: *Wonder en is gheen wonder*—a marvel and yet no marvel. Arguing from this and the impossibility of perpetual motion, which he took as an axiom, he deduced the force required to keep a smooth body in equilibrium on an inclined plane and used this as the basis of his investigations into the laws of statics, including the parallelogram of forces, by the aid of which he solved quite complicated problems concerning weights supported by connecting strings. He carried out important work on hydrostatics, including the establishment of Pascal's paradox, that the pressure on the base of a vessel containing a liquid depends only on the depth, and in no way on the form of the vessel, with the familiar consequences for communicating vessels. He also treated the stability of floating bodies—"floating top-heaviness", as he called it.

However, this is but a small part of Stevin's performance. His work on arithmetic and algebra earned him an honourable place in Cantor's "Geschichte der Mathematik". He was the first to introduce the systematic use of decimal fractions, but with a clumsy notation, and he advocated the general use of the decimal system in coinage, weights and measures. His very rare little tract on terrestrial magnetism, "De Havenvinding" (1599), translated at the time into English under the title "The Haven-finding Art", contains valuable records of the magnetic declination, which he proposed to make a basis of navigation. As adviser in scientific and technical matters to Prince Maurice of Nassau, he was extensively concerned with many aspects of engineering, in particular with matters of drainage and hydraulic engineering generally. He was a leader of the Dutch school of fortification which arose early in the seventeenth century. On all these practical matters he wrote extensively. Among his inventions was a sailing chariot, long one of his most popularly celebrated achievements, which comes in for comment in "Tristram Shandy". He was, above all things, an experimenter, and his fundamental experiment on the time of fall was both earlier and more conclusive than that of Galileo. He let fall together two spheres of lead, one ten times heavier than the other, from a height on to a board. The sounds of impact were simultaneous. He was quite clear on the part played by air resistance in the fall of light bodies.

The fame of Stevinus was much hindered by the fact that, for reasons of principle, he published the greater part of his work in the Dutch language, on the history and merits of which he wrote extensively, and sometimes fantastically. He was for this reason little read outside the Netherlands until the posthumous appearance of an important part of his work in French. An accessible and critical edition of his work has thus long been desirable.

This volume under review is the first of a new edition of the "Principal Works of Simon Stevin", which is being produced by the Koninklijke Nederlandse Akademie van Wetenschappen, with the financial support of several Dutch organizations interested in learning. The complete works are not contemplated, both because of the forbidding bulk and because several of them are not of sufficient originality or interest to demand reprinting. This first volume bears the general description "Mechanics" and is edited by E. J. Dijksterhuis. It contains "De Beghinselen der Weeghconst"—"The Elements of the Art of Weighing"—which includes the work on statics already referred to, and "De Beghinselen des Waterwichts"—"The Elements of Water Pressure" (that is, of hydrostatics). The Dutch text is given in facsimile on the left-hand page and an English translation, by Miss C. Dikshoorn, on the right—an excellent arrangement. So far as I know, this is the first English translation, and the French translation, by Albert Girard, issued in 1634 as part of a large folio, the "Œuvres Mathématiques", leaves out certain parts that the editor thought of little interest. This is, then, clearly the text that the student requires. Considering the present eclipse of classical learning, it might have been well to furnish a translation of the Latin and Greek prefatory verses by Jan de Groot.

The book is prefaced by an introduction giving the scanty facts known of Stevin's life and a sketch of his work. There is also a bibliography which cannot be said to be very satisfactory, a comment which needs no amplification in face of the frank admission: "For readability's sake no attempt at bibliographical correctness has been made". The books in question are so rare—of one booklet the only copy then extant was lost when the library at Louvain was burnt in 1914—that a full and conventional bibliographical description would have been appropriate.

The undertaking so well launched is sure of a warm welcome from all students of the history of science, and the future volumes are awaited with pleasant expectation. E. N. DA C. ANDRADE

THE OUTLOOK FOR MAN

The Foreseeable Future

By Sir George Thomson. Pp. viii+166. (Cambridge: At the University Press, 1955.) 10*s.* 6*d.* net.

THIS book is not so much about the future of mankind as about the tools which man is likely to possess for shaping his future during the next few decades and the technical limits within which the advance of civilization is possible. In non-technical language Sir George Thomson first explains clearly the scientific principles which will determine the broad lines of technological progress; and then, in a series of fascinating chapters, he shows even the non-technical reader just how these principles of impotence, as he terms them, set the limits to the increase of supplies of energy and its more effective utilization, to the exploitation or improvement of the materials available for us, to our powers of handling very complex problems (for example, by means of the new electronic digital computers) and

to the great extension in biological knowledge. These are the four fields in which he anticipates the major advances of the future, and the possibilities are indicated realistically as well as with vision.

The chapters in which this is done for energy and power, for materials, for transport and communications and for meteorology are the best in the book. Those on food and on some applications of biology are equally imaginative but are sometimes less convincing, and some of his suggestions may be open to challenge. Where Sir George's predictions do not lend themselves to interesting discussions, they should go far to correct unreasonable expectations, as, for example, when he discusses the prospects and implications of nuclear energy. He sees limits to the extension of television for entertainment, but discusses its possibilities in regard to business communications and also gives reasons for believing that the practical limits of speed in transport have now been reached. It will surprise some to find the Master of Corpus Christi College, Cambridge, discussing space travel seriously, even if he thinks it unlikely to yield practical advantages which will offset the many technical difficulties. Climatic change is also regarded as a serious possibility, whether by the production of artificial rain or by the biological method of growing plants in desert areas and so obtaining the absorption of radiation by the ground.

Here, at least, Sir George reflects that schemes of this kind may have to wait for a world government; but when he discusses food and the applications of biological science, he is apt to disregard the social, moral and political factors which are involved in the prospects he expounds so imaginatively. He does not expect that any one line of advance will supply the complete answer to feeding the world's growing population; but he predicts that, in the long run, plants, moulds and bacteria bred for the purpose will compete successfully with the chemist in making some of the more complicated compounds, and he looks to a large increase in synthetic foods, particularly for feeding cattle, for which purpose he suggests they may be delivered automatically at distributing centres. Improvements in plant and animal breeding will also make a big difference to agriculture and to the world's supply of food. On the population question as a whole, however, his most interesting suggestion is that medical research should concentrate increasingly on the prevention, and at first the postponement, of old age rather than on the further reduction of the killing diseases.

One interesting possibility he suggests is that domestication of the monkey could put at man's disposal for crop picking a combination of hand and eye through a moderately intelligent brain that is one of the best bargains Nature has to offer us. When, however, he comes to discuss the social consequences of technological advances, Sir George is less satisfactory and convincing. He admits that civilized man is at present rather like a child who has been given too many toys for his birthday; but none the less he seems to lay all the stress on the tools rather than on the men and women who use them. In the transformed and enriched world he contemplates, there appears to be no real place for values. His treatment of thought is purely materialistic and leaves no room for art, religion, patriotism, humanitarianism or the like. There is no apparent recognition in this book that even the advance of science and technology does not depend simply on material conditions but on such values as freedom of thought and investigation and tolerance, for example, the future of which depends ultimately on ideas and man's spiritual outlook.

Such conditions and ideas, far more than nuclear power, the electronic computer or biological advances, may yet determine the extent and pace of mankind's development, or indeed whether civilization continues and does not collapse; and it is for this reason that there is a certain naïvety about some of the discussion in this book of social questions, as when, for example, Sir George is worried about the consequences of the elimination, by mechanization or automation, of routine work and the onus of finding work for the more stupid and also the more rapidly multiplying part of the population. The solutions, he suggests, involve moral judgments, and in this field the rate of advance is apt to be set not so much by what is technically possible as by what is politically and socially feasible.

Here, of course, we enter on the question of education, on which Sir George has some interesting comments, even if sometimes, as when he refers to the release of man's brains from past hindrances and to the possibility of biological improvements, he seems to be reaching into a very distant if not a doubtful future. He visualizes a much larger proportion of people engaged on work which demands some training in science, and he recognizes the dangers of specialization and the increasing difficulty of acquiring width of knowledge. He stoutly champions the interpreter or expositor of scientific and technical knowledge, and however much one may wish that Sir George had dealt adequately with the human values, the book at least establishes his own claims as an expositor of the first order.

R. Brightman

TECHNOLOGY OF SOUND

Sonics

Techniques for the Use of Sound and Ultrasound in Engineering and Science. By Theodor F. Hueter and Prof. Richard H. Bolt. Pp. xi+456. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 80*s*. net.

SOME years ago I was asked by a farmer the best method of improving his wheat crop recently harvested. He had read in the press that it is possible to refine grain by the application of ultrasonic power! Information on the applications of acoustic vibration in processing, analysis and instrumentation has only been available to the reader of a large assortment of journals, and to those fortunate people having access to the classified literature of the research establishments of the Armed Services. It is not surprising that these techniques have been hailed in not too well-informed quarters as the panacea of all evils. This is doubly unfortunate because it has led to more than the occasional attempted application where a more thorough knowledge of the physical limitations would have precluded the attempt. It has also meant that particular applications have not always been investigated sufficiently to determine their full technical and economic promise. The book under review should do much to help those interested in techniques for the use of sound and ultrasound in science and engineering.

'Sonics' is defined by the authors as "the technology of sound as applied to problems of measurement, control and processing". The authors wisely

ignore the usual division of acoustics into sound and ultrasound, which is of no significance in this technology. The first three chapters of the book are concerned with establishing in some detail the fundamentals of vibration and sound, and of radiation. Here we find an introduction to such concepts as acoustic analogy, acoustic impedance, reflexion and transmission, energy density and intensity, radiation pressure, the decibel scale and diffraction. In Chapters 4 and 5 the principles and design of piezoelectric and magnetostrictive transducers are considered. Chapter 5 is particularly useful in that it summarizes in some detail much that has not been readily available.

The remainder of the book deals with the three facets of the technology—power or processing applications, testing and analysis of fluids and materials, and instrumentation and control. Information is given on the physical principles involved in processing and the practical design of transducers. This latter covers, as well as the transducers already considered, electrodynamic, fluid dynamic and siren sources. There is a useful section on cavitation. Under testing and analysis, the various methods at present available for determining the propagation velocity and attenuation are discussed, as is also the relation of these quantities to the physical properties of the medium. A mainly theoretical appendix effectively summarizes our knowledge of acoustic relaxation mechanisms in fluids.

It should be emphasized that the authors have attempted to discuss the general principles of the technology rather than to consider all known applications. This approach should be of greater value. In their presentation they have sought to steer a middle course between a script intelligible only to the advanced physicist and one dealing with technical details of specific designs. They have also assumed little knowledge of acoustics proper, but some understanding of electronics. Substantially, they have succeeded in their plan by using a relatively simple presentation and recourse to intuitive arguments, with the addition of footnotes and sections in small type to augment the discussion. The inclusion in the book of design tables, graphs and formulæ, together with practical instructions, considerably increases its usefulness. The M.K.S. system of units is used; but other units are also indicated on some graphs and tables. Tables for the conversion of units from one system to another are included. Many references to the literature are given, including those to extensive bibliographies. It has been a pleasure to read and review this book.

H. D. Parbrook

LAND AND PEOPLE: 1955–80

World Population and Resources

A Report by PEP. Pp. xxxvii+339. (London: Political and Economic Planning, 1955.) 30*s*. Distributed by George Allen and Unwin.

THE Demographic Revolution has joined the Agrarian Revolution and the Industrial Revolution as a significant mechanism of change in the course of human history. Whether one regards it as an embarrassment in a specific historical situation is largely a matter of one's political or national affiliations, but it remains a fact to be faced. In this report Political and Economic Planning (PEP) discusses the wide range of problems attendant upon the almost inevitable increase of 25 or 30 per cent in the world population (now estimated at 2,500 million) within the life-time of an already adult generation. Many have said that this generation is frightening itself with phantoms of Neo-Malthusianism which the next generation will exorcise using the formulæ of nuclear energy, algæ culture, watered deserts, and the rapid diffusion of 'Western' standards of 'social responsibility' through Africa and Asia. Political and Economic Planning, however, does not anticipate that any significant new technological contribution will alleviate a deteriorating situation during the twenty-five years ahead. It recognizes, of course, that fundamental discoveries are being made, but argues in terms of distribution and costs to the peasant whose income is only a fraction of our own.

The ecology of human societies embraces the mastery of techniques of production and distribution, and of social organization. In assessing the balance of populations against their respective resources, one can scarcely avoid finding that solutions to specific problems are not judged by scientific standards alone, but also in terms of politics and morals. It would be very convenient if the willing gift of mortality control to the under-developed lands were acknowledged by equally willing acceptance of fertility control, but there are ancient prejudices to be overcome. A highly urbanized society with a high standard of living moves spontaneously towards low fertility; the most immediate problem is the control of fertility in illiterate rural societies. Mortality control finds ready and public acceptance; but fertility control remains a sensitive and controversial issue for the individual. Here is the basic social problem.

Theories of control based on the 'rhythm' method can be viewed against the account given here of the difficulties of teaching it in an Indian village. Interested readers might refer to the Milbank Memorial Fund Report for 1954 for a considered statement and discussion of the Catholic attitude. Incidentally, the Marxist thesis that there is no population problem, only a social problem, and that every mouth brings with it a productive pair of hands, is considered and rejected. In brief, Political and Economic Planning is not optimistic about the prospects of the poor and densely populated countries combining a stable population with an increasing standard of living in any future we can usefully consider. It couples recognition of the values of family and social responsibility with an appeal to biologists to work energetically (and with increased support!) towards the new philosopher's stone, an oral contraceptive which is cheap, effective and acceptable to all creeds and cultures.

The report falls into three major sections: a general survey of population and resources, a series of comparative studies of countries at various stages of economic and demographic development, and thirdly, a study of "Nation and Family" in the context of attitudes towards fertility control. The whole provides an extremely valuable summary of the most useful facts (closely up to date), clearly arranged and leading to a carefully accurate review of the problems and issues at stake. Discussion throughout is brief, to the point and realistic, and based on authoritative sources and opinion. Its value as a text for students will be enriched if read along with Prof. W. A. Lewis's important chapter on "Population and Resources" in his recent "Theory of Economic Growth".

Maurice Kirk

Into the Blue

The Lake Tana Expedition. By Lionel Ferguson. Pp. 255+16 plates. (London: William Collins, Sons and Co., Ltd., 1955.) 16*s*. net.

NUMEROUS undergraduate expeditions have gone, either privately or under the auspices of clubs such as the Oxford University Exploration Club, to many parts of the world in recent years. Their success generally depends upon the adequacy of their preparation and organization, the nature of the guidance received from individuals and from institutions like the Royal Geographical Society, the assistance given by governments and commercial firms, and, above all, upon the enterprise and determination shown by the individual members. Success came to this party of five Cambridge undergraduates —three geographers, a historian and an economist— because their expedition showed signs, in varying degrees, of all these requirements.

As an expedition to undertake a geographical survey in the Lake Tana area of Ethiopia it failed, since barely two out of the eighteen weeks of the expedition could be spent there. Thus its 'findings' are superficial and of no scientific value, which is unfortunate, for there must be a wealth of unrecorded material in the region. The party met with a long chain of misfortunes, including frequent mechanical trouble with their car, and the withholding of official permission to follow certain routes across the Sudan. All types of people, whatever their colour, status or wealth, showed great kindness and gave much practical help, both before and during the expedition. From the geographer author one might have hoped for more about the landscape and the people of the areas through which the party travelled in three continents; and the accounts of the social contacts of the several lengthy enforced halts might have been considerably shortened.

But any blemishes of content, like those of style, are insignificant alongside the many traces of the perseverance and determination of these five young men who overcame so many difficulties, actual and political. They fully deserve the kind words of Sir Brian Robertson who, having met them in Cairo, contributes a foreword. "To travel is always good," he writes, "but to travel hard and far on little money and in limited time is first-class education."

R. W. Steel

Some Fundamentals of Petroleum Geology

By Dr. G. D. Hobson. Pp. x+139. (London: Oxford University Press, 1954.) 18*s*. net.

THIS book descends to basic principles of petroleum in no uncertain manner. It is not, however, a recapitulation of time-honoured theories of origin, migration and accumulation, for this, as the author observes, "has already been written many times in the voluminous literature on this subject". Dating the industry from Drake (1859), if we consider all happenings since then—the enormous, world-wide, technical evolution, with its vast ramifications and impacts on the progress of mankind—then it is incongruous that to questions of oil-genesis, mechanism of mobility and factors governing its selection of resting places, answers are still tentative, especially concerning beginnings.

In my experience, most authors of 'petroleum geologies', while proclaiming their own fancies, sooner or later return to conventional treatments of prevalent theories, discarding some from now accepted weaknesses, and then forsaking the reader to sort it all out for himself. This tendency to leave things 'in the air' is the reason why, to-day, there is no scientific unanimity on vital issues. Dr. G. D. Hopson here steps in with a new broom, skilfully manipulated, to sweep away dead wood of unprofitable theory within a compass of five original and stimulating essays.

The first essay, "Nature of an Oil Accumulation", deals with reservoir rock, fluid distribution and final retention. "Reservoir Fluids: their Composition and Properties" follows, and next is "Origin of Petroleum", embracing conditions of formation; source-material; amount, distribution of organic matter; agents; and thermal, radioactive and biochemical transformations. "Migration and Accumulation", comprising buoyancy, interfacial tension, compaction and general mechanics of fluid movement and other conceptions, leads to a final dissertation on "Reservoir Pressure". This book is not only a critical survey of past controversial thoughts, but also an incitement to clearer thinking on this complex substance—petroleum—from which every oil technologist will benefit.

H. B. Milner

Ier Symposium International de Bactériologie Alimentaire

Organisé par la Section de Microbiologie des Produits Alimentaires de l'Association Internationale des Sociétés de Microbiologie, Institut Pasteur de Lille, 10–14 Octobre 1954. Bactériologie des Semi-Conserves de Viandes—Rapports, Communications et Discussions. (Annales de l'Institut Pasteur de Lille—Vol. 7, 1955.) Pp. 266. (Paris: Éditions Médicales Flammarion, 1955.) n.p.

THIS symposium dealt with the bacteriology of non-sterile processed meats, participation being limited to specialists, invited from sixteen different countries. The volume gives a complete account of their scientific proceedings: sixteen substantial papers (reports), and nineteen shorter communications, with discussions. Seventeen of the papers are in English and fourteen in French; four in German are provided with English and French summaries. Major papers have reference lists.

The topics range over the whole subject. After definitions, and an exposition of characters desired by the user, several papers deal with the processes to which these products are subjected. Two papers surveying the whole bacterial flora are followed by several on the occurrence and significance of the important types of bacteria: *Cl. botulinum*, other clostridia, staphylococci, members of the Enterobacteriaceae, streptococci, lactobacilli, corynebacteria, micrococci, and the *Achromobacter–Pseudomonas* group. Next the bacteriological condition of ancillary ingredients like gelatin and spices is considered. Techniques used in different countries for the bacteriological examination of these foods are then compared, and the problems of representative sampling described. Finally, after discussion of the translation of such observations into bacteriological standards, there is a description of the bacteriological conditions generally agreed as desirable in canned ham.

Much of this information, especially that from overseas, is not readily available elsewhere. Because it is uniquely comprehensive, up to date and authoritative, the volume might be regarded as indispensable to all—from the manufacturer to the analyst and inspector—who are concerned with the bacteriology of such foodstuffs.

M. Ingram

SCIENTIFIC CENTENARIES IN 1956

By JOAN M. EYLES

THE ranks of well-known scientists have always included not only those who have made major contributions to their branch of science, but also those who have been responsible for some standard text-book, which has caused their name to become familiar to thousands of students. One of the earliest of these successful authors was John of Holywood, better known as Sacrobosco—the Latinized version of his name. A Yorkshireman by birth, he studied at Oxford and then taught mathematics in Paris. Sacrobosco flourished in the thirteenth century, and manuscript copies of his treatise on spherical astronomy, "Sphaera Mundi", must have been circulated widely. Two centuries later, the advent of printing greatly increased its circulation. The first printed version appeared at Ferrara in 1472, to be followed by another twenty-six editions before 1500, and fifty more in succeeding years. The last, bearing the Leyden imprint, was dated 1647. Sacrobosco wrote other treatises, including one on the art of numbering, which played an important part in popularizing the use of Arabic numbers. He died in Paris, and the year of his death is usually taken to be 1256.

Passing on three hundred years, we come to Luca Ghini, an Italian botanist who died on May 4, 1556. He was appointed "Reader in Dioscorides" at Bologna in 1527, and many of his pupils became famous, including Aldrovandi and the English botanist William Turner. Ghini is thought to have been the first to use dried plants for scientific purposes, and the earliest known herbaria, in the modern sense, were all made by his pupils.

Another botanist, who died a century after Ghini, was Walter How, born in London in 1620 and educated at the Merchant Taylors' School and at St. John's College, Oxford. How practised as a physician in London, and was the author of "Phytologia Britannica", which appeared anonymously in 1650. This has been regarded as the first British flora, though some local lists preceded it. How died when only thirty-six, on August 31, 1656, and was buried at St. Margaret's, Westminster.

During the Civil War, Walter How was captain of a cavalry troop on the side of King Charles. On the opposing side we find Edmund Wingate (1596–1656), mathematician and lawyer, who chose to support the Parliamentarians, although he had been tutor to Queen Henrietta Maria when she was a girl in Paris. Wingate's career bears some resemblance to that of Sacrobosco, for he too was a Yorkshireman, studied at Oxford and taught at Paris, and was also the author of some frequently re-printed books. His "Arithmetick made easy" achieved a nineteenth edition in 1760, although by that time it was so altered that it would scarcely have been recognized by its author. Wingate was member of Parliament for Bedford in 1650, and died in London in December 1656.

Jean Baptiste Morin (1583–1656), who in 1630 became professor of mathematics at the Collège Royal in Paris, has been called the last of the astrologers. His horoscopes were highly thought of, and he was consulted regularly by Cardinals Richelieu and Mazarin, receiving from the latter a handsome pension.

An eminent Italian of this period was Marco Aurelio Severino (1580–1656), who became professor of anatomy and surgery at Naples in 1610, and whose teaching drew students to Naples even from regions north of the Alps. His "Zootomia Democritae", published at Nuremberg in 1645, was the first comprehensive treatise on comparative anatomy. In the last section of this book he describes methods of dissection and recommends the use of the microscope, "invented in our life-time". He was in his seventy-sixth year when he died of the plague in Naples. His books, particularly the "Zootomia", are extremely rare.

The most important tercentenary of the year is undoubtedly that of the birth of Edmond Halley, the gifted mathematician, astronomer and pioneer meteorologist who is also remembered for the part he played in the production of Newton's "Principia". Halley was born on October 29, 1656, in the parish of St. Leonard's, Shoreditch, and received his education at St. Paul's School and at Queen's College, Oxford. His first paper (one on astronomy) was read to the Royal Society when he was only nineteen, and during the next sixty years more than eighty papers appeared in the *Philosophical Transactions* under his name. Towards the end of 1676 Halley went to St. Helena, where he spent more than a year making astronomical and meteorological observations, publishing on his return a catalogue of southern stars, which was followed a few years later by the first map of the trade winds. In 1684 he made his famous visit to Newton at Cambridge which led the latter to prepare the "Principia". In 1686, after the first part had been delivered to the Royal Society, Halley not only undertook to supervise the printing, but also made himself responsible for the entire cost. This was because at that time the finances of the Royal Society were so low that it was not only unable to carry out its original resolution to pay for printing the "Principia", but was even unable to pay Halley, then assistant secretary, his promised stipend of £50 a year. In July 1687, in the same month that Halley sent Newton twenty copies of the "Principia" to "bestow on your friends in the University", he accepted seventy copies of Willughby's "De Historia Piscium", published the previous year by the Royal Society, in lieu of some eighteen months salary.

The rest of Halley's career must be passed over quickly. It includes two sea voyages in command of H.M. Pink *Paramour*, the principal object of which was to make observations on the variations of the compass; sixteen years as Savilian professor of geometry at Oxford; and twenty-two years as Astronomer Royal at Greenwich. Seventeen years after his death the comet whose orbit he had calculated returned as he had predicted, thereafter to be known as Halley's Comet.

A friend and correspondent of Halley, William Molyneux (1656–98), was elected a Fellow of the Royal Society in 1685. He was founder and first secretary of the short-lived Dublin Philosophical Society, the forerunner of the Royal Dublin Society

founded in 1731. In 1692 Molyneux published "Dioptrica Nova", which contained an appendix by Halley.

Another contemporary scientist interested in optics was the Dutch microscopist Nicolaas Hartsoeker, born on March 26, 1656. He published in 1694 an "Essai de Dioptrique" in which he illustrated his invention, the screw-barrel microscope, generally associated with the name of Wilson, who introduced it to England. Hartsoeker was elected a foreign associate of the French Academy of Sciences, when it was re-constituted in 1699. He died in 1725.

The celebrated French botanist, Joseph Pitton de Tournefort, was also born in 1656, on June 5, at Aix, in Provence. Tournefort studied medicine at Montpellier, and made many botanical journeys, particularly in the Pyrenees, where he suffered great hardships. He was appointed demonstrator at the Jardin des Plantes, Paris, in 1683; and during 1700–2 travelled in Greece and Asia Minor. He died in 1708 as the result of a street accident in Paris. An account of his travels in the Near East appeared in 1717 and was translated into English in the following year. Tournefort's system of plant classification, first described in his "Élémens de Botanique", 1694, was artificial, being based on differences in the corolla, but it was popular and widely used until that of Linnæus was adopted.

The two hundred and fiftieth anniversary of the birth of Benjamin Franklin, American philosopher and statesman, occurs on January 17 (N.S.). The anniversary of the death of John Evelyn, on February 27, 1706, also calls for mention here. Evelyn, best known as a diarist, was closely connected with the early years of the Royal Society, and on two occasions was urged to accept nomination for the presidency, but refused the honour. His book "Sylva" was a valuable account of arboriculture, and his "Fumifugium: or the Inconvenience of the Aer and Smoak of London dissipated" strikes quite a modern note.

It is surely unusual, if not unique, for four generations of a family to succeed one another as directors of a scientific establishment. Jacques Cassini (1677–1756) was the second member of the famous family of French astronomers who for well over a hundred years were in charge of the Paris Observatory. All became Academicians and also Fellows of the Royal Society. Cassini II opposed Newton's theory that the Earth was an oblate spheroid, flattened at the poles, he and his supporters holding that it was flattened at the equator. Two celebrated expeditions, sent by Louis XV to measure a degree of latitude, one in Lapland and the other near the equator in South America, had by 1745 proved that Cassini was wrong and Newton right. Cassini died at Thury, near Clermont, on April 18, 1756.

Not many years after the French expedition had returned from South America, a young Welshman, Lewis Evans, who had emigrated in his youth to North America, was busy carrying out a topographical survey of Pennsylvania. His map of this region, published in 1749, was followed by one that is better known, his "Map of the Middle British Colonies", showing the valley of the Ohio and its tributaries. It was a remarkable achievement, and was re-printed many times—mainly in pirated editions. Evans was a keen observer and recorded many interesting physiographical and geological notes, both on his maps and in his journals[1]. He died on June 11, 1756.

The name of 'lieberkuhn' used to be given to the concave mirror once used on microscopes to illuminate small opaque objects. Its inventor, J. N. Lieberkühn (1711–56), a German physician and microscopist, not only made excellent microscopes, but was also esteemed for his injected preparations, some of which he is said to have exhibited to the Royal Society, when he was in London about 1740. In particular he studied the structure of the small intestine, describing the Lieberkühn's crypts, as they were later named.

In the field of chemistry, the bicentenary of the birth of J. A. C. Chaptal (1756–1827) is of interest. Chaptal occupied for a time the chair of chemistry founded for him at Montpellier; but he concerned himself especially with applying the new chemical discoveries of his day for the benefit of industry and agriculture. His ability was recognized by Napoleon, who made him Minister of the Interior. During his tenure of office, Chaptal did much to promote applied science. After the fall of Napoleon he was obliged to retire, but in 1816 was nominated a member of the Academy of Louis XVIII.

Although the physician and mineralogist Dr. William Babington (1756–1833) made no outstanding contribution to science or medicine, he deserves remembrance as the senior member of those who founded the Geological Society of London in 1807. In his house this small group of enthusiasts first met, sometimes at seven in the morning, for Babington was a busy physician; and it was he who provided accommodation for the Society's mineralogical collection, until a room at 4 Garden Court, Temple, was obtained in 1809. Babington was president of the Society during 1822–24, and some years later, at the age of seventy-seven, his unabated enthusiasm led him to enrol in a chemistry class held at the new University of London (now University College).

Others born in 1756 include Sir Everard Home, brother-in-law of John Hunter, who gave nineteen Croonian lectures to the Royal Society; Francis Egerton, the eighth Earl of Bridgewater, whose will provided for the famous Bridgewater Treatises; and John Loudon MacAdam, who did so much to improve British highways.

First among those who died in 1856, and whose centenaries will be commemorated this year, is the Italian physicist, Amedeo Avogadro. To-day his name is familiar to every student of chemistry, yet during his lifetime his now famous hypothesis was almost ignored. Avogadro was born in Turin in 1776 and, like Lavoisier, trained as a lawyer, becoming a Doctor of Laws in 1796. But the laws of Nature appealed to him more than the laws of man, and turning to the study of science, in 1806 he began teaching mathematics and physics. The classical paper in which his molecular theory was first expounded was published in the *Journal de Physique* in 1811. This was followed by others, but his views remained unheeded by chemists for forty years or more. Avogadro died in 1856, and it was his countryman Cannizzaro who succeeded, a few years later, in convincing some chemists that Avogadro's hypothesis could be used for bringing order to the complicated matter of atomic weights and the correct formulæ of compounds. Some years were to elapse before acceptance became general, and not until then did Avogadro receive his due meed of recognition as one of the founders of theoretical chemistry. In 1911, a century after the publication of his first memoir, representatives of the scientific world gathered to see the King of Italy unveil a monument to Avogadro in the city of Turin, where all his work had been carried out.

A brilliant young French chemist, C. F. Gerhardt (1816–56), died only a month after Avogadro. With Laurent, he criticized the dualistic theory of Berzelius, and played an important part in the determination of atomic weights and concordant molecular formulæ. Gerhardt taught chemistry in Montpellier and in Paris, but in 1855 was appointed professor of chemistry in Strasbourg, where he died a year later.

Another scientist who, like Avogadro, was too much in advance of his time to receive adequate recognition from his contemporaries was the Russian mathematician Nikolas Lobatchewsky (1793–1856), who wrote the first book on non-Euclidean geometry (the name was given by Gauss). It was published in Russian during 1829–30, and was translated into German in 1840. Lobatchewsky was born in Nijni-Novgorod, but spent most of his life in Kazan, where he was first student, then professor and finally rector of the University. He has been called the Copernicus of geometry; but in his lifetime made little impression and was even, in 1846, inexplicably relieved of his chair and rectorship by the authorities. He died, infirm and sightless, on February 26, 1856.

Two well-known geologists, one English, one Scottish, died in 1856. The senior, the Rev. William Buckland, taught geology in Oxford for more than thirty years, first as reader in mineralogy, then in geology. He did much to render the subject popular, and his lectures and field-classes were always well attended. He was president of the Geological Society in 1824, the year its dining club was founded, and it is entertaining to learn that at the first meeting the Rev. Prof. Buckland bet Mr. Warburton (a former president) two bottles of champagne to one that of several toads enclosed in rock cavities by Mr. (later Sir Charles) Lyell, one would be found alive at the end of a year. As two toads were found alive a year later, the genial Buckland was adjudged to have won his bottle of champagne. Buckland was on excellent terms with Sir Robert Peel, who, while he was Prime Minister, frequently consulted Buckland on scientific matters. Peel nominated Buckland as Dean of Westminster in 1845. A few years later the Dean was overtaken by illness, and he died on August 24, 1856.

Hugh Miller (1802–56), the Scottish geologist, is widely known as the author of that popular and almost classic work, "The Old Red Sandstone". A stone-mason by choice rather than necessity, he worked for some fifteen years among the rocks in which he found so many treasures. His keen observation, coupled with a gift for prose description, resulted not only in remarkable reconstructions of the fossil fishes he collected so patiently, but also in books that were to awaken widespread interest in the methods and results of scientific inquiry. In 1839 he moved to Edinburgh, where he died in tragic circumstances on December 23, 1856. The little thatched cottage at Cromarty where he was born is still maintained as a memorial and museum. In 1938 it was taken over by the National Trust for Scotland, which in 1952 held a meeting there to celebrate the sesquicentenary of Miller's birth[2].

Among the geologists one might also include W. H. Pepys (1775–1856), for he was one of the original founders of the Geological Society. He was, however, better known as a chemist, and in particular as the constructor of some exceptionally large voltaic piles and batteries.

Two amateurs of science call for brief mention here. One is Agostino Bassi (1773–1856), an Italian micro-scopist who showed that a vegetable micro-organism could be a cause of infection, and thereby ranks as one of the pioneers of the germ theory of disease. The other is the British naturalist William Yarrell, a fine shot and angler, and the author of two works on British birds and British fishes which were for long the standard authorities for naturalists. Yarrell contributed many papers, including the first detailed description of the kiwi, to the *Transactions of the Linnean* and *Zoological Societies*.

Outstanding on the list of those born in 1856 is the name of J. J. Thomson, under whose direction the Cavendish Laboratory at Cambridge became a great centre of research. Thomson enjoyed a tremendous reputation as a leader of research, and not only did he himself gain a Nobel Prize in 1908 for his theoretical and experimental investigations into the transmission of electricity through gases, but no less than nine of those who had worked under him at Cambridge were also awarded Nobel Prizes. In 1918 he became Master of Trinity, and shortly afterwards resigned from the Cavendish professorship. Numerous honours came his way, including knighthood in 1908 and the Order of Merit in 1912; as well as the Royal, Hughes and Copley Medals of the Royal Society. He served as president of the Society during 1915–20. Thomson died on August 30, 1940, in his eighty-fifth year, and was buried in Westminster Abbey.

Among the names of French mathematicians, that of Emile Picard ranks high. Picard, born in Paris on July 24, 1856, was only twenty-four when he published the celebrated memoir on integral functions which made his name and inspired many others to make new discoveries in the field of analysis. His influence was profound, for he was an accomplished teacher as well as an outstanding mathematician. A member of thirty-seven foreign academies, and permanent secretary of the Academy of Sciences in Paris, in 1924 he was accorded the rare distinction of a seat in the literary section of the Institute of France. He died on December 12, 1941.

C. D. T. Runge, born at Bremen on August 30, 1856, was professor of mathematics at Göttingen during 1904–24; as well as attaining eminence as a mathematician, he also achieved distinction in physics, his work on spectral series giving him a place among those whose work formed the experimental basis of quantum mechanics. Runge died at Göttingen in 1927.

In the field of botany, an interesting centenary is that of A. F. W. Schimper (1856–1901), who took a foremost place in establishing the science of plant ecology. His book, "Plant Geography", has become a classic. He travelled widely, and was one of the first to prepare a map of plant distribution.

Two biologists who were born in 1856 achieved distinction. Sir Edward Poulton, for forty years Hope professor of zoology at Oxford, was an enthusiastic Darwinist, and made the problem of mimetic resemblances his especial study. He was president of the British Association when it met at Nottingham in 1937. He died six years later at the age of eighty-seven. E. B. Wilson, American biologist, had a great influence on the study of embryology. He studied the growth of the nucleus, and introduced the conception of cell-lineage. A Foreign Member of the Royal Society, he gave the Croonian Lecture in 1913. Another American who should be remembered this year is R. H. Chittenden (1856–1943), who directed the Sheffield Scientific School at Yale during 1898–

1922. He was an early worker in the study of gastro-chemical processes, and became world famous as an authority on nutrition.

Other centenaries falling this year include those of J. B. Senderens (1856–1937), the French chemist who was associated with Sabatier in the discovery of the hydrogenation of oils by catalysis; and E. J. Bevan (1856–1921), who jointly with C. F. Cross succeeded in obtaining viscose from cellulose in 1892. Two Americans who made notable discoveries in the field of technology were F. I. Ives (1856–1937), who invented the first successful half-tone process in printing in 1878, and was also an early worker in colour photography; and E. G. Acheson (1856–1931), who patented a successful process for the artificial production of graphite, and developed its use as a lubricant.

In the field of technical chemistry, however, the most important centenary of the year is undoubtedly that of the discovery of the first aniline dye, made by William Henry Perkin in 1856, which is to be marked by celebrations next May. It is proposed to set up a trust fund to finance Perkin Centenary Scholarships, so linking the past and the future, and this seems a particularly satisfactory way of celebrating a centenary.

[1] White, G. W., "Lewis Evans' Contributions to Early American Geology—1743–1755". *Illinois Academy of Science Trans.*, **44**, 152 (1951).

[2] Bailey, E. B., *Nature*, **170**, 790 (1952).

CENTENARY OF *THE ENGINEER*

By W. J. PRIEST

THIS week, *The Engineer* has celebrated its centenary. A special number of the journal has been published which contains, in addition to a short history, articles by twenty-six eminent authors, which constitute a study of influences on engineering advancement during the past hundred years.

The first number of *The Engineer* appeared on January 4, 1856, and apart from two gaps, caused by the general strike in May 1926 and by the national fuel crisis in February 1947, its weekly publication has been regular and continuous. Although it is not quite the oldest technical journal in Britain, *The Engineer* can claim to be the oldest weekly newspaper serving the interests of engineers in every branch of the profession and industry which it represents. The paper was founded by Edward Charles Healey, a young man of thirty-three, who, it is said, was interested, among many other things, in railway development. The Great Exhibition of 1851 had undoubtedly given an impetus to mechanical invention; there was a place for a journal in which the many engineering developments of the time could be recorded and commented upon. It was that place which *The Engineer* was destined to fill. For seventy-three years the journal continued in the ownership of its founder's family, his son, Sir Charles Chadwyck-Healey, Bart., and a grandson, Sir Gerald Chadwyck-Healey, Bart., in turn succeeding to the chairmanship of *The Engineer* Ltd., while a second grandson, Mr. O. N. Chadwyck-Healey, became managing director. In 1929, *The Engineer* Ltd. amalgamated with Morgan Brothers (Publishers) Ltd. and a new company was formed, retaining the second firm's name, with Sir Gerald Chadwyck-Healey as its first chairman, and Mr. O. N. Chadwyck-Healey as a joint managing director. Now, Mr. O. N. Chadwyck-Healey is the chairman, and Mr. C. A. Chadwyck-Healey, a great-grandson of the founder of *The Engineer*, is the assistant managing director of the owning company.

From the start, the journal promised impartiality in taking "cognisance of all new works relating to the useful arts and allied subjects". In addressing itself to its readers, in the first issue, *The Engineer* declared that "every new moon is witness to the advent of some invention, some happy discovery, or successful application, some change at least, which like more fuel, becomes new incitement to fresh efforts. There is, therefore, no want of scope under the title we have assumed". Certainly, as the years of its first momentous century have rolled by, the scope of the journal has been ever-widening; there can have been few developments in the vast field of engineering progress which have not had some place in its columns.

During its first century *The Engineer* has had five editors, and the service of three of them—the Pendreds—now extends over a period of no less than ninety years. For its first two years, the paper was edited by a Mr. Allen, about whom next to nothing is known apart from the fact that his office was at 32 Bucklersbury, in the City of London, while the publisher's headquarters were at 301 Strand. After Allen's resignation in 1858, an American engineer named Zerah Colburn was appointed by Edward Healey to "an influential position on the staff". Colburn had come to Britain a year earlier in order to study railway development. He was possessed of a photographic memory, wielded a brilliant pen, and in many respects has been accounted a genius. But Colburn's eccentricities were many, and by the end of 1864 his resignation was inevitable.

It was then that Vaughan Pendred, a young Irishman who had lately come to Britain to make his way as an engineer, was invited to take the editorial chair. His letters and articles had attracted the attention of the proprietor of *The Engineer*, and Vaughan Pendred's appointment undoubtedly marked the beginning of a new and greatly improved relationship between owner and editor. Vaughan Pendred missed no opportunity of extending the field and increasing the influence of his paper, and he took early steps to depart from such traditions of technical journalism as then existed. In its early years, *The Engineer* relied mainly on patent specifications for its illustrations; but Vaughan Pendred held that the current engineering practice of the day should be more fully represented, and he persuaded manufacturing and constructional engineers—not without some difficulty, it is said—to permit him to publish drawings of their actual products. For forty years, Vaughan Pendred, who was a master of technical description and criticism, edited the paper, and on his retirement in 1905, he was succeeded by his second son, Loughnan St. Lawrence Pendred, who had become his father's first full-time assistant nine years earlier. L. St. L. Pendred's editorship lasted for

forty-one years. He guided *The Engineer* through two World Wars and through the period of depression between those Wars, he ensured that the paper kept pace with the demands of the day, and he rendered innumerable services to the engineering profession generally, among which must be recalled his presidency of the Institution of Mechanical Engineers in 1930. In 1934, L. St. L. Pendred was created C.B.E. in recognition of his work for engineers, and by that time his younger son, Benjamin W. Pendred, had joined the editorial staff. He succeeded his father as editor-in-chief in April 1946—a position which he still occupies.

It is impossible within the compass of this article to make more than a passing reference to the contents of *The Engineer* over its first hundred years. The paper has carefully reported engineering, and many other scientific, developments as they have occurred, but (as was promised in its first issue) it has not confined itself merely to furnishing "a dry register of the progress of machinery". The paper has always covered a broad canvas. There have been articles by many distinguished contributors, such as those, in 1866, by W. J. Macquorn Rankine on "Simple Rules for Practical Calculations of the Efficiency of Steam" and by Prof. John Tyndall on "Ice and Glaciers". In 1867 Samuel Smiles was writing in *The Engineer* about Richard Trevithick's place in the early history of the locomotive, while in 1937, much nearer to the present time, there appeared special articles like those by the late Sir Leonard Hill on "Air Conditioning" and by Sir Harry Ricardo on "Prospects of the High-Speed Heavy Oil Engine". Contributions of this order by distinguished authors have regularly had a place alongside descriptions of all kinds of engineering works, reports of technical meetings and exhibitions, and surveys of economic and labour affairs. At the same time, there has been a place for brief, and interesting, notes such as one, many years ago, setting down the time taken by the winner of "The Derby" as recorded by Benson's chronograph!

The diversity of interest revealed in earlier volumes of *The Engineer* continues unabated. The first hundred years of the journal cover a period in which steam power has reached its zenith and has declined as the utilization of electrical and internal combustion engine power has rapidly advanced. There has been outstanding progress in aeronautics, metallurgy, radio and telecommunications, while the construction of great civil engineering works, the development of mass-production methods, and, not least, the educational and sociological advances in engineering have time and again proved to be of outstanding importance. All of them are matters which have claimed the close attention of *The Engineer*. As the paper moves into its second century, subjects like the fuller development of the gas turbine, nuclear power and automation are prominent. The tempo of technological progress all over the world continues to increase; but there is no doubt that *The Engineer* will continue effectively to record that progress.

ANTIPROTONS

By Prof. O. CHAMBERLAIN, Prof. E. SEGRÈ, Dr. C. WIEGAND and Dr. T. YPSILANTIS
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SINCE the development of Dirac's theory of the electron and the brilliant confirmation of one of its most startling predictions by the discovery of the positron by Anderson, it has been assumed most likely that the proton would also have its charge conjugate, the antiproton. The properties that define the antiproton are: (1) charge equal to the electron charge (also in sign); (2) mass equal to the proton mass; (3) stability against spontaneous decay; (4) ability to become annihilated by interaction with a proton or neutron, probably generating pions and releasing in some manner the energy $2\ mc^2$; (5) generation in pairs with ordinary nucleons; (6) magnetic moment equal but opposite to that of the proton; (7) fermion of spin $\frac{1}{2}$. Not all these properties are independent, but all might ultimately be subjected to experiment.

In cosmic rays, where such antiprotons could appear, some events have been observed which could be due to antiprotons; but their interpretation is uncertain.

In order to generate antiprotons in the laboratory, an absolute lower limit of the necessary energy is $2\ mc^2 = 1{\cdot}88$ BeV.; but the mechanism of the collision and the conservation of momentum influence this lower limit, which becomes 5·6 BeV. if the process is a nucleon–nucleon collision, or 4·4 BeV. if the process is a two-step one with the formation of a pion in a nucleon–nucleon collision followed by a pion–nucleon collision in which the nucleon–antinucleon pair is generated. These thresholds can be lowered appreciably by internal motions of nucleons in the nucleus. (Energies are quoted in the laboratory system.)

When the Berkeley bevatron was planned, the goal of 6 BeV. was set, in the hope that this energy would be sufficient to create antiprotons.

The methods of detection of the antiproton can make use of any of the seven properties listed above. It seemed that (1), (2) and (3) might be the easiest to ascertain; (4) would also be highly desirable; whereas (5)–(7) are at present very difficult to observe.

There are classical methods of measuring charge and mass of a particle that go back in their origin to J. J. Thomson. They entail the simultaneous measurement on the same particle of any two of the quantities momentum, velocity or energy, which in turn can be obtained from the observation of electric or magnetic deflexions, time of flight, range, scattering in photographic emulsions, etc. As for the charge, it is sufficient to measure its sign and its absolute value in a rough way only, because it is assumed that it is an integral multiple of the electronic charge.

After a detailed discussion, it was decided that momentum p and velocity v constituted the most promising combination for ascertaining the mass. The first successful experiment[1] was performed at

the end of September 1955, as follows. The momentum was measured by passing the particles generated by bombardment of a copper target with 6·2 BeV. protons through two deflecting magnetic fields and two magnetic lenses. This ensemble let through only particles for which $p = 1{\cdot}19$ BeV./c, if their charge is equal to that of the electron, including sign. The velocity was measured by a time-of-flight measurement between two scintillation counters 40 ft. apart. The pulse-size in the scintillators showed that the particles were singly charged.

The chief difficulty of the experiment rests with the fact that the antiprotons are accompanied by many pions—44,000 pions per antiproton in the most favourable conditions. For this reason provision must be made for eliminating spurious background effects. One of the most important steps is the insertion in the beam of two Čerenkov counters: one that is activated by particles with $v/c = \beta > 0{\cdot}79$, and one of a special type that is activated by particles with $0{\cdot}75 < \beta < 0{\cdot}78$. Pions with $p = 1{\cdot}19$ BeV./c have $\beta = 0{\cdot}99$, while antiprotons of the same value of p have $\beta = 0{\cdot}78$, and their respective times of flight for an interval of 40 ft. are 40×10^{-9} sec. and 51×10^{-9} sec. Particles with β in the interval between 0·75 and 0·78 trigger the sweep of an oscilloscope in which the time of flight between two scintillation counters 40 ft. apart is displayed. This time of flight appears as the distance between the two 'pips' due to the traversal of the counters. From this time of flight the mass is determined with an accuracy of 10 per cent for each particle. Up to now, about 250 particles have been observed and the average mass is known to about 5 per cent. It is $1{,}840 \pm 90$ electron masses.

The functioning of the whole apparatus is checked by sending through it positive protons in a separate run. These are obtained from a subsidiary target, and their orbits are selected in such a way that they have the same momentum as the antiproton.

The particles are observable after a time of flight of 10^{-7} sec., which rules out particles with a mean life much shorter than 10^{-8} sec., in particular the known hyperons. These measurements are thus in agreement with points (1), (2) and (3) mentioned above, and the identification of the new particle with the antiproton is a natural one, although not absolutely established.

There are also some indications on the fourth point mentioned above, namely, the terminal process of the particle. Particles selected as antiprotons by the apparatus of ref. 1 were sent into a block of heavy glass and the Čerenkov radiation generated in it was measured[2]. This radiation does not correspond, of course, to the entirety of the energy released; actually it is only a small part of it. However, a calibration was performed, and from the pulse size the visible energy was estimated. Values up to 800 MeV. were found. This is consistent with the expected modes of annihilation for an antiproton, and with the energy it would throw into Čerenkov radiation in a detectable form; but it is not sufficient yet for positive identification on that score only.

Another type of observation on the terminal phenomenon accompanying the absorption of the antiproton was also performed[3] with the photographic plate technique. Particles of selected momentum obtained with an arrangement similar to that described in ref. 1 were slowed down by a copper absorber and finally stopped in a stack of photographic emulsions. Among a background of many pions one particle was found which has protonic mass, comes to rest and produces a star containing six black tracks, one grey proton, one pion of 58 MeV. and one minimum ionization track. The visible energy released is larger than 830 MeV. The total energy released cannot be known, because there are neutral particles emitted; but this amount of visible energy is also consistent with the annihilation of an antiproton.

Clearly many questions are raised by the new particle. Its identification should be further corroborated; it is important to study in detail its annihilation properties for complex nuclei and, possibly even more interesting, the annihilation with hydrogen and deuterium. In addition, the cross-section for nuclear interaction and the mechanism of production are clearly to be investigated.

The existence of the antiproton entails with virtual certainty the existence of the antineutron. Its experimental demonstration is a most interesting problem. Probably the neutron beam of the Berkeley bevatron contains an appreciable number of them, but their disentanglement from the ordinary neutrons appears a formidable task. It is likely that the best approach will be either: (1) to transform an antiproton into an antineutron by a collision with a proton; or (2) to convert an antineutron into an antiproton by collision with an ordinary neutron and detect either the final antineutron in (1) or the final antiproton in (2).

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INTERNATIONAL COMPARISONS OF RADIOACTIVITY STANDARDS

DURING the period May 1952–November 1954, international comparisons have been made of standard samples of the radioactive nuclides sodium-24, phosphorus-32, cobalt-60, strontium-90 + yttrium-90, iodine-131 and gold-198. The organizations taking part in these measurements and comparisons have been the United States National Bureau of Standards, Atomic Energy of Canada, Limited, and four British laboratories (the National Physical Laboratory, the Atomic Energy Research Establishment, Harwell, the Royal Cancer Hospital, London, and the Medical Research Council, London, co-ordinated through the National Physical Laboratory Advisory Committee on Radioactive Standards). Periodical meetings between representatives of the three countries have been arranged by the United States National Research Council Sub-committee on Beta- and Gamma-ray Measurements and Standards. Several papers on the work have already appeared (refs. 1–12).

The samples used for the comparisons were standard solutions prepared by the U.S. National Bureau of Standards, excepting the strontium-90 + yttrium-90 samples, which were prepared by the

Atomic Energy Research Establishment, Harwell. The solutions generally contained a few microcuries per gram. In the case of cobalt-60 and iodine-131, stronger solutions containing of the order of one millicurie per gram were provided. The disintegration-rates of the samples were determined at each of the laboratories by one or more of the following methods: total β-counting in a 4π solid angle, $4\pi\beta\gamma$- and $\beta\gamma$-coincidence counting, and $\gamma\gamma$-coincidence counting. The results of measurements under what are considered to be the best conditions attainable at present are in agreement to within about ± 2 per cent, except for 4π-counting of low-energy β-rays.

In measurements of sodium-24 and gold-198 by $4\pi\beta$-counting, the fractional losses of β-particles by absorption are small and the results agree within ± 2 per cent. They also agree within these limits with $4\pi\beta\gamma$- and $\beta\gamma$-coincidence results. The basic counting measurements for iodine-131 are in agreement within 1 per cent, but there is some uncertainty concerning the allowance to be made for self-absorption. No such allowance was applied by the British and Canadian laboratories; but it has been calculated by the National Bureau of Standards to be about 2 per cent. Owing to the complex disintegration scheme of iodine-131, there is unfortunately no ready means of providing a cross check. The apparent systematic difference of about 3 per cent between the National Bureau of Standards results for iodine-131 and the standard of this nuclide at present adopted in Great Britain and at Chalk River is thus attributable to the correction assumed for self-absorption.

Agreement to within ± 1 per cent was obtained in the measurements of cobalt-60 by $\beta\gamma$- and $\gamma\gamma$-coincidence counting. A wide range of values by $4\pi\beta$-counting was, however, reported by the British laboratories. Subsequent investigations at the National Bureau of Standards showed that, owing to the relatively low energies of the β-particles, the apparent disintegration-rates obtained by $4\pi\beta$-counting were critically dependent on the amount of solid material in the source and on its distribution. Consideration of the cobalt-60 results leads to the conclusion that, owing to the precautions necessary in the preparation of the source, and the uncertainties in the absorption corrections, the $4\pi\beta$-counting method of standardizing this nuclide is at present less reliable than the coincidence method. It is, however, considered that the disintegration-rate of the solution distributed was determined by the coincidence method to an accuracy approaching ± 1 per cent.

Ionization chamber equipment for preserving standards of the nuclides used for these comparisons has been set up at the National Bureau of Standards, and similar equipment is being calibrated at the National Physical Laboratory. The co-operation between the American, Canadian and British laboratories on all matters relating to the establishment and the maintenance of radioactivity standards is to be continued in order to check the agreement already attained, and to extend the comparisons to other nuclides. It is hoped that standardizing laboratories in other countries will participate in future comparisons; those interested should write to the most convenient of the authors of this communication.

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TURBULENCE IN THE ATMOSPHERE AND IN THE OCEAN

THE study of atmospheric turbulence can reasonably be regarded as having been started some fifty years ago by the distinguished oceanographer, Ekman. Since then, it has progressed in the intermittent way of most branches of science, and at the present it appears to be in a state of flux.

Up to a few years ago, advances in atmospheric turbulence were usually achieved by exploiting the basic similarity between laws of flow on the laboratory and on the atmospheric scale, together with ingenious and painstaking confirmatory observations. These were, for technical reasons, usually made in the lowest 10 m. of the atmosphere, where the horizontal shearing stress can be taken as independent of height, although there were occasional explorations to the top of what was called the 'frictional boundary layer', at about 1 km., beyond which the eddy transfer of momentum was thought to be negligible. The turbulence was often regarded as fluctuations in the wind, temperature and humidity which were too rapid to be recorded by conventional meteorological instruments.

In 1949, however, Priestley made a pioneer statistical study[1] of the horizontal transfer of heat and momentum by motions of large scale, using wind and temperature observations made at daily intervals

at all levels over Larkhill. His technique, which was perhaps influenced by the earlier work of Jeffreys and Defant, has since been used by others; it provides a convincing demonstration of the obvious fact that atmospheric turbulence cannot be identified with motions of any particular scale.

The close link between motions on all scales is well shown by the work of Sheppard, Charnock and Francis[2], who from observations made near the Scilly Isles suggested that over the ocean in the Westerlies the shearing stress did not vary with height up to the maximum height observed, about 1 km., and probably beyond. The implication was that the shearing stress was due to turbulent transfer of momentum down a gradient of mean momentum, the gradient being due not only to friction but also to a horizontal gradient of temperature, a thermal wind. The classical concept of a limited friction layer was not valid, at least over the ocean. This work, taken together with that of Priestley and others, fits well with recent models of the general circulation of the atmosphere in which the effects of motion on all scales play a part.

This broadening of the scope of atmospheric turbulence has raised new problems, not only of physics but also of nomenclature; in particular, since turbulence can no longer be regarded as the embroidery on the anemograph, some workers find it convenient to regard the word 'turbulence' as connoting a technique for determining, usually by statistical methods, the properties of any field of flow. This has the great virtue of bringing into the open the difficulties associated with the wide spectrum of atmospheric motions. When used as other than a technique, the word turbulence usually seems to be qualified in some way—by small-scale or large-scale, or by the ubiquitous medium-scale—the word turbulent being used only in such platitudes as "the atmosphere is turbulent on a broad range of scales". The result is that, at a meeting to discuss atmospheric turbulence, the papers may include almost any aspect of dynamical meteorology. This was certainly the case at a symposium held at the summer meeting of the Royal Meteorological Society held at Ashburne Hall, University of Manchester, during July 22–23. Of the four papers presented, one was concerned with motions through the whole atmosphere, two dealt with motions in the lowest 2 km. and one attempted to bridge the gap between small-scale near-surface flow and that at greater heights. A fifth paper, presented in a symposium on oceanographical topics, described eddying motion in tidal flow near the sea bed.

Prof. P. A. Sheppard presented a joint paper on medium-scale turbulence in trade-wind air, which described the results of an expedition to a small island in the West Indies to make observations similar to those made earlier at the Scilly Isles. On fifteen days out of a total of twenty-seven, balloons were released from the upwind shore at intervals of about 10 minutes and were observed every 20 seconds, using two theodolites. The particular interest of such observations in the trades is that the directions of the mean surface wind and the thermal wind are opposed (there was a maximum in the profile of mean wind-speed at a height of a few hundred metres) and that cumulus convection is almost always present. Fluctuations from the mean flow were analysed using averaging periods increasing from 3 hours up to the whole 27-day period. Over this period it was found that horizontal momentum was being transferred to the north by the larger-scale motions which were sampled, a smaller amount being transferred to the south by motions of smaller scale. On no scale was there equipartition of turbulent energy between the three velocity components, the root-mean-square energy in the vertical being one or two orders of magnitude less than that of the horizontal components. A complete account of the results of the expedition is to be published; they will add to our knowledge of the medium-scale turbulence and of the momentum transfer it brings about in this important region.

Mr. F. B. Smith then read his paper on geostrophic and ageostrophic wind analysis[3], in which he estimated the work done over the British Isles by the atmospheric pressure field set up by differential heating. He first reduced the equations of motion to an approximate but observable form which involved the geostrophic and ageostrophic components of the wind-velocity and the radius of curvature of the isobars. These he had obtained by drawing charts using British radio-sonde data at nine levels for every third day of 1953. The rate of production of kinetic energy was found to be of the same order as that found by Brunt by considering dissipation by small-scale turbulence, but it appeared to be differently distributed with height. The flow across the isobars was found to be about the same as would be predicted using the well-known Ekman distribution, again as used by Brunt; some check on this estimate was obtained by calculating the life of typical depressions, which was found to agree with observation. This paper is a good illustration of the close link between motions on the largest and smallest scales.

Turbulence of medium scale is being investigated by Dr. F. Pasquill, who presented a preliminary report of the diffusion of fluorescent dust over distances of some tens of miles and heights of some thousands of feet. The dust particles, of zinc cadmium sulphide, diameter 0·5–3μ, were sampled by the Meteorological Research Flight using an airborne sampler. Individual particles of dust can be counted later, since they fluoresce when irradiated with ultra-violet light. Results so far indicate that the distribution of the dust has the same form at all heights. The height of the cloud was much less than the width: the width did not increase uniformly with distance; the angle subtended at the release point by the cloud at forty miles distance was about half that subtended by the cloud at a mile or so.

Earlier diffusion experiments in Great Britain have been of a smaller scale and usually confined to the lowest 30 m., where the wind direction does not change appreciably with height. The interpretation of these observations of diffusion at greater heights is complicated by the variation of wind with height both in speed and direction.

The variation of wind with height has been studied by many workers since Ekman fifty years ago. It is now well known that in the lowest 10 m. or 100 m. the eddy viscosity increases linearly with height, and Dr. T. H. Ellison described the wind-field to be expected if this linear variation were maintained to greater heights. The solution he has derived has many points of interest and, of course, reduces to the familiar logarithmic distribution of wind with height near the ground. It is possible to allow for the effect of a thermal wind of simple form, and the resulting modification helps in the interpretation of observations such as those described by Prof. Sheppard, particularly over the ocean.

A paper presented by Prof. K. F. Bowden in an oceanographical symposium is also appropriate to this account. He has made measurements, in collaboration with Mr. L. A. Fairbairn, of fluctuations of the three components of current in tidal streams in the Irish Sea using an electrode flowmeter designed at the National Institute of Oceanography. The meter is complicated but seems quite suitable for recording fluctuations in current; the velocity of the mean current is not recorded. Prof. Bowden gave a good deal of information about the correlations of the fluctuating currents, and it was clear that much valuable work remains to be published.

H. Charnock

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NEWS and VIEWS

New Year Honours List

The following names of scientists and others associated with scientific work appear in the New Year Honours List:

Baronet: Sir Hubert Houldsworth, chairman of the National Coal Board.

K.C.B.: Sir Frederick Brundrett, chairman of the Defence Research Policy Committee and scientific adviser to the Minister of Defence.

K.B.E.: Alexander Glen, secretary, Department of Agriculture for Scotland.

D.B.E.: Prof. Kathleen Lonsdale, professor of chemistry and head of the Department of Crystallography, University College, London.

Knights: Dr. Eric Ashby, president and vice-chancellor of The Queen's University, Belfast; Dr. Ralph G. Hawtrey, president during 1946–48 of the Royal Economic Society, for services to the study of economics; Dr. Joseph Burtt Hutchinson, director of the Empire Cotton Growing Corporation's Cotton Research Station, Namulonge, Uganda; Dr. Eric J. F. James, high master, Manchester Grammar School; Walter Mercer, professor of orthopædic surgery, University of Edinburgh, president of the Royal College of Surgeons, Edinburgh; Prof. Alfred G. Pugsley, professor of civil engineering, University of Bristol; Prof. Samuel McM. Wadham, professor of agriculture, University of Melbourne, for public services; Prof. Solly Zuckerman, Sands Cox professor of anatomy, University of Birmingham, deputy chairman of the Advisory Council on Scientific Policy.

C.B.: Dr. W. Cawood, principal director of scientific research (air), Ministry of Supply; W. C. M. Couch, deputy director of electrical engineering, Admiralty; H. Hardman, deputy secretary, Ministry of Agriculture, Fisheries and Food; W. J. Richards, director of the Radar Research Establishment, Ministry of Supply.

C.M.G.: J. A. Beckett, assistant secretary, Ministry of Fuel and Power; F. S. Collier, forestry adviser to the Secretary of State for the Colonies; Prof. S. H. Roberts, vice-chancellor of the University of Sydney; Dr. J. A. Venn, president of Queens' College, Cambridge, lately chairman of the Colonial Studies Committee.

C.B.E.: Prof. C. E. H. Bawn, Grant-Brunner professor of inorganic and physical chemistry, University of Liverpool; W. H. Cashmore, director of the National Institute of Agricultural Engineering, Silsoe, Bedfordshire; S. H. Clarke, director of the Fire Research Station, Department of Scientific and Industrial Research; H. V. Disney, chief engineer, Industrial Group Headquarters, Risley, United Kingdom Atomic Energy Authority; Dr. A. T. Doodson, director of the Liverpool Observatory and Tidal Institute; Prof. W. P. Evans, professor of chemistry, Canterbury University College; R. Graham, director of aircraft research and development, Ministry of Supply; H. V. Hayes, director of air technical publications, Ministry of Supply; W. E. Hiley, director, Woodlands Research Department, Dartington Woodlands, Ltd.; C. E. Hudson, senior education and advisory officer, National Agricultural Advisory Service, Ministry of Agriculture, Fisheries and Food; H. D. Lewis, assistant secretary, Ministry of Agriculture, Fisheries and Food; Prof. J. R. Matthews, lately chairman of the Scottish Committee of the Nature Conservancy, and chairman of the council, Macaulay Institute for Soil Research; T. N. Mitchell, president of the Royal Agricultural Society, State of Victoria; Dr. A. S. Parkes, director of the Division of Experimental Biology, National Institute for Medical Research; Dr. H. Richardson, principal of the Bradford Technical College; H. D. Skinner, director of the Otago Museum and lecturer in anthropology in Otago University; H. C. Smith, secretary of agriculture, State of Tasmania; Dr. Kenneth M. Smith, director of the Virus Research Unit (Agricultural Research Council), Molteno Institute, University of Cambridge; R. S. Stafford, technical director, Handley Page, Ltd.; W. G. Rodway, for anti-locust work in East Africa; S. G. Wilson, director of veterinary services, Northern Region, Nigeria.

Archæology in the University of London: Prof. V. Gordon Childe

Prof. V. Gordon Childe is retiring from the chair of prehistoric European archæology in the University of London and the directorship of the Institute of Archæology in Regent's Park. We may hope that he will have a very happy period of retirement and that his increased leisure will enable him to give us the results of his mature conclusions. Childe is an Australian and was at Oxford when the First World War started; at the time his health was not good, but after the War he spent a long time in Central and Eastern Europe. It was here that his great knowledge of, and interest in, the early story of mankind in these areas developed. For a short time he acted as librarian at the Royal Anthropological Institute, but shortly after this the new Abercromby professorship of archæology at Edinburgh was founded and Gordon Childe was its first holder. Most of the students there only took archæology as a subsidiary subject, though there were a few honours candidates. Prof. Childe was very popular with his students and laid the foundation of what has become an important archæological school. He also did a considerable amount of archæological investigation in Scotland, and his work at Skara Brae is well known. Later Childe was offered and accepted a

chair in the University of London, which carried with it the directorship of the Archæological Institute of the University. Here again with his colleagues he built up an important school, and one can only regret that his retirement occurs before the Institute moves into more official quarters in the new University building itself. It is to be hoped that, as is the case at Cambridge, the University of London may yet see its way to recognize archæology as an honours school for degree-giving purposes. It is well known that Childe holds strong ideological views not acceptable to everyone, but that must not be allowed to obscure the enormous amount of solid factual archæological work and teaching that he has accomplished; he is one of the leading prehistorians to-day.

Mr. W. F. Grimes, C.B.E.

The University of London Institute of Archæology, founded with a voluntary staff and director in 1937, has been directed since 1946 by the professor of prehistoric European archæology in the University, Prof. V. Gordon Childe; but since it has been receiving financial support from the University of London the Institute has extended so rapidly, and in particular the teaching work in prehistoric European archæology has increased so much, that on the resignation of Prof. Childe the Senate has decided to separate the posts, and has invited Mr. W. F. Grimes to accept the directorship. Prof. Gordon Childe's resignation from his double post takes effect on September 30, 1956.

Mr. Grimes, a graduate of the University of Wales, began his professional archæological career as assistant in the National Museum of Wales. While there he conducted many important excavations on prehistoric and Roman sites, undertook comprehensive field surveys of prehistoric monuments, and wrote a "Guide to the Collections illustrating the Prehistory of Wales". This was published in 1939, but republished in 1951 as "The Prehistory of Wales"; for it was, in fact, far more than a guide, but presented Welsh prehistory in its British and European setting. At the end of 1938 Mr. Grimes was appointed assistant to the Archæological Officer in the Ordnance Survey; but on the outbreak of war he was seconded to the Ministry of Works to conduct rescue excavations on archæological sites threatened by the construction of aerodromes or military works. These excavations resulted in many important discoveries, of which only a small part has yet been published, a full publication by H.M. Stationery Office being in preparation. At the end of the War, Mr. Grimes was appointed director of the London Museum when Mr. (now Sir Mortimer) Wheeler was appointed director-general of archæology in India. It thus fell to Mr. Grimes to find a new home for the Museum that was ejected from Lancaster House, and to install the collections in their new premises in Kensington Palace. At the same time Mr. Grimes had to organize and direct the excavations of the bombed sites in the City of London that have brought to light so many new details as to the topography and architecture of the Roman and medieval city, including the Temple of Mithras. Mr. Grimes is now president of the Council for British Archæology.

The Engineer

This week sees the centenary of *The Engineer* (see p. 10 of this issue), and a special issue has been prepared to mark the occasion. It is a remarkable and absorbing compilation, with its 124 pages of editorial matter and its 300 or so pages of advertisements. The Editor has assembled a notable collection of articles from leading authorities on the development and present situation in the main fields of engineering. These have been grouped into six sections, concluding with a fine series of coloured plates of modern manufacturing plant and products. The articles range from one by Sir Albert Pugsley on "Scientific Discovery" to others by Sir Christopher Hinton on "Nuclear Power", Dr. H. A. Thomas on "Electronics" and Dr. D. F. Galloway on "Production Methods"; between them these two give a good condensed picture of the present and future influence of automatic control in industry. Attention is also paid to engineering materials with articles on "Iron and Steel", "Non-ferrous Metals", "Concrete" and "Plastics". The publishers are to be congratulated on producing a volume, worthy of their high reputation, which will be of permanent value and interest.

Institute of Metals: Medal Awards

The Institute of Metals has awarded the following medals: *Institute of Metals Medal in Platinum* (1956), to Prof. G. L. Chaudron (professor at the Sorbonne and director of the Vitry Laboratory of the Centre National de la Recherche Scientifique), in recognition of his outstanding contributions to knowledge, particularly in the field of the light metals, which have greatly benefited the metal industries; *Rosenhain Medal* (1956), to Dr. D. McLean (principal scientific officer, Metallurgy Division, National Physical Laboratory, Teddington), in recognition of his outstanding contributions to knowledge in the field of physical metallurgy; *W. H. A. Robertson Medal* (1955) and premium of fifty guineas, to E. J. Thackwell (Northern Aluminium Co., Ltd., Rogerstone, Mon.), for a paper on the choice and construction of monolithic linings for twin-bath induction furnaces for melting aluminium alloys.

Staffing the United Kingdom Atomic Energy Authority

An adjournment debate on the staff of the Atomic Energy Authority, opened by Mr. A. Neave, was held in the House of Commons on December 21, and in replying for the Government the Minister of Works, Mr. N. Birch, said that, since the annual report of the Authority was issued, further measures have been taken to improve the pay and conditions; these should give the Authority greater flexibility and enable it to compete successfully with outside industry. As regards the transfer of staff from the Civil Service, 78·5 per cent of the Civil servants now with the Authority have accepted the offers; 10·5 per cent have rejected them and 11 per cent have not yet notified the Authority of their wishes. Only 8 per cent of the professional and scientific staff have decided not to avail themselves of the offer, whereas 15 per cent of the executive and clerical staff have rejected them. Many of these latter are of considerable seniority, but the numbers are not large and most of the wastage has been made good without much difficulty. As regards training, there are comprehensive schemes for craft and student apprenticeships, and practical training is sometimes provided for students before they enter the university or after graduation. Very special consideration has been given to 'sandwich' courses, and the Authority also runs a large number of advanced courses in nuclear

technology within its own organization. Sympathetic consideration has been given to the difficulties experienced in getting technical training by staff at such places as Dounreay and Calder Hall, but Mr. Birch was unable to say anything more in reply to Mr. Neave's suggestion for a large central institution for nuclear physics or nuclear technology. The Minister thought that any real danger of widespread redundancy is remote whatever the future of nuclear weapons; the Authority would be only too glad to utilize any skilled personnel released from the weapons group. Mr. Birch could say nothing definite about the future pattern of the Authority. It is a pioneering organization, he said, which must keep abreast of advances in scientific thought and of new knowledge. Both scientific and administrative skill are needed, and the Authority will continue to require to recruit good men for its expanding field. Mr. H. Usborne suggested that the Authority is recruiting an excessive proportion of young engineers.

International Control of Nuclear Weapons

REPLYING to questions in the House of Commons on December 19, the Minister of State for Foreign Affairs, Mr. A. Nutting, said that no specific action has yet been taken on the proposal he made in the United Nations Disarmament Sub-Committee on October 7 for a conference of scientists representing each member country of the Sub-Committee to report on the possibilities of controlling nuclear weapons. A variant of this proposal was contained in a resolution passed by the United Nations Assembly the previous week, but was opposed by the U.S.S.R. Nevertheless, said Mr. Nutting, the Government is still seeking to get agreement to some scheme of this kind and has not abandoned hope of a disarmament agreement on conventional weapons, although it also hopes ultimately to achieve a comprehensive agreement embracing nuclear weapons when means of control have been discovered.

Journal of Analytical Psychology

ALTHOUGH the followers of Freud have been well supplied with literature, the disciples of Jung have not been so fortunate. It is therefore gratifying to find that the Society of Analytical Psychology, London, has decided to produce its own journal, called the *Journal of Analytical Psychology* (1, No. 1 (1955); published by the Tavistock Publications, Ltd., 2 Beaumont Street, W.1; 12*s*. 6*d*. per issue or 21*s*. per vol. of two issues). In this first issue it is stated that "the decision to launch a Journal of the Society did not spring only from the publicly expressed observation that we produce no journal, but also, indeed one could say mainly, from the internal vitality of its members, now over forty in number". In the past the writings of the Jungian school have tended towards theorization rather than a clinical approach, and it is a good thing that most of the papers here are concerned with patients rather than myths. Nevertheless, since mythology and anthropology play such a large part in the Jungian approach, a great deal of space is devoted to the relationship of dreams to primitive thought. The most important paper in this issue is that of J. Layard, on boar-sacrifice, in which the dream of a patient about cooking ham and being chased by a pig is related to the ritual sacrifice of pigs in Malekula. Another long paper is by Robert F. Hobson, on archetypal themes in depression, and Robert Moody writes on the function of counter transference. L. Stein writes on loathsome women, and Amy Allenby on the father archetype in feminine psychology. Anthony Storr contributes a note on cybernetics and analytical psychology. There is also a long critical notice on the collected works of C. G. Jung and on Jung's "Answer to Job". It is difficult for anyone who has not been educated in the Jungian discipline to evaluate these papers. Those used to analysing dreams by free association, using the patient's interpretation, are likely to feel that they might have been interpreted otherwise, but in any event such clinical work is always of interest. It is to be hoped that this journal prospers, if only for the fact that it allows one to see how others are thinking.

University of Sheffield

THE following have been appointed to lectureships in the University of Sheffield: Miss S. K. R. Clarke (bacteriology and virus diseases) and R. G. Siddall (fuel technology and chemical engineering). The present chair of fuel technology and chemical engineering in the University is to be called the Newton Drew chair in memory of the late Mr. and Mrs. W. Newton Drew. Mr. Newton Drew served on the University Council (1924–34), and was also treasurer of the University (1926–32) and a pro-chancellor (1932–34); Mrs. Newton Drew served on committees of the University for many years, and both were generous donors to the University. The present occupant of the chair is Prof. M. W. Thring.

Announcements

THE Charles Mayer Prize of the Société de Chimie Biologique has been awarded for 1955 to Prof. S. Ochoa (University of Chicago) and Mme. M. Grunberg-Manago (of the Centre National de la Recherche Scientifique, France). The Prize, which is worth 500,000 francs, has only recently been created and is to be awarded annually, provisionally until 1960, for distinguished work on nucleoproteins.

MR. G. F. ADAMS, scientific adviser to A. Gallenkamp and Co., Ltd., and Mr. H. B. Toft, formerly principal of Bath Technical College and recently a sales executive of the Company, have been elected to the board of directors of A. Gallenkamp and Co., Ltd.

THE Royal Agricultural Society of England is offering its annual Research Medal, together with an award of a hundred guineas, for work of outstanding merit carried out in the United Kingdom which has proved, or is likely to prove, of benefit to agriculture. Recommendations for the award can only be made by the head of the university department or research organization concerned. Such recommendations, with nine copies of the candidate's relevant papers, should be sent before January 31 to the Secretary of the Society at 16 Bedford Square, London, W.C.1.

THE Education Panel of the Corrosion Group of the Society of Chemical Industry has established a prize of 25 guineas, to be awarded annually, for an essay or paper on any aspect (not necessarily research) of the corrosion of metals and its prevention. Competitors must not be more than twenty-seven years old, and their contributions, which may contain diagrams and photographs, should be about three thousand words in length. Entries must be submitted before March 31 to the Corrosion Group Essay Competition, c/o Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

SCIENCE AND DEFENCE IN GREAT BRITAIN

THE statement made by the Prime Minister, Sir Anthony Eden, in the House of Commons on October 25, on the administrative responsibilities of the Minister of Defence made no specific reference to the position of the Defence Research Policy Committee. Sir Anthony stated that arrangements have been made to co-ordinate, under the Minister of Defence, planning and training for the joint action of civil and military forces in home defence. The Minister of Supply has become a fourth Defence Department within the co-ordinating powers of the Ministry of Defence, and the Minister is now responsible for seeing that the composition and balance of forces within individual Armed Services meet the strategic policy laid down by the Defence Committee. A new post of chairman of the Chiefs of Staff Committee, to which Sir William Dickson has been appointed, has been created, and this officer will normally be the United Kingdom representative on the Military Committee of the North Atlantic Treaty Organization and on other international defence organizations.

These arrangements were discussed in a debate on the Armed Services in the House of Lords on November 8 and 9, in which the importance of research and of the scientist in defence was repeatedly stressed. In reply to Lord Swinton, who had urged that the Minister of Defence should also be responsible for deciding what research programmes should be undertaken and their priority, the Lord President of the Council, Lord Salisbury, said that the Minister of Defence has already been given responsibility for framing general policy governing research and development. Lord Rea suggested that the immensely accelerating rate of scientific discovery imposes on the Government a great responsibility to assess the future in terms which no individual past training and no previous experience can fulfil. Lord Hore-Belisha, too, was concerned as to the extent to which the scientist exerts an effective influence on policy, and Lord Freyberg also urged that a forecast of the effect of scientific invention upon the conduct of future wars should precede any reorganization or amalgamation of the Services. No one outside those responsible for the conduct of research knows either the aim of scientific invention or what has already been accomplished. Lord Balfour, in particular, emphasized the need for scientifically trained personnel in the Services, and doubts were freely expressed as to the extent to which amalgamation is possible and the level at which integration is desirable.

The Parliamentary Secretary to the Ministry of Defence, Lord Carrington, replying to the debate, assured the House that the Government attaches the greatest importance to scientists playing a sufficient part in the central organization for defence. The chairman of the Defence Research Policy Committee attends meetings of the Chiefs of Staff Committee whenever he wishes, and Lord Carrington doubted whether a week passes without him discussing some matters personally with the Chiefs of Staff. Although he is not a member of the Defence Committee, his views are invariably known to, and expressed by, the Minister of Defence, and the Defence Committee on occasion invites him to attend. The Chiefs of Staff have also asked the Scientific Adviser to the Minister of Defence to be the chairman of sub-committees to consider long-term problems. Lord Carrington emphasized that there is always a strong representation of scientists at the major exercises held by the Service Departments and the North Atlantic Treaty Organization; scientists are encouraged to put forward their ideas, and they are warmly welcomed by members of all three Armed Services.

THE BRITISH FLORA DURING 1955

STUDY of the British flora during 1955 has led to no outstanding additions to the list; but collectively the results represent important progress. This includes interesting extensions of the known range of some of the less-common species, a clearer understanding of the taxonomic value of various units, and the recognition of new ones. These, and other aspects, were illustrated by the exhibits at the annual exhibition meeting of the Botanical Society of the British Isles, arranged in the lecture room of the British Museum (Natural History) on November 28.

The meeting was attended by some three hundred members and guests, and a full account of the exhibits will appear in the *Proceedings* of the Society.

During the year many field botanists have been concentrating on work in connexion with the Distribution Maps Scheme[1] organized by the Society. The direct results of this were shown in an exhibit prepared by the Cambridge headquarters of the Scheme, which included a map showing the 10-km. squares of the National Grid for which lists of more than 50, 150 and 250 species, respectively, have been received. Although considerable gaps still remain, the progress of the work, which is still only in its second year, is well up to expectations. Mr. F. Perring and Dr. S. M. Walters (Cambridge) also showed examples of distribution-patterns revealed in the course of local surveys for the Scheme around Newton Stewart (Galloway) and Llanrhaiadr (Denbigh and Montgomery).

A by-product of the Scheme was the discovery of *Orchis militaris* in Suffolk, where a colony of more than five hundred plants was found by a worker listing the species of a 10-km. grid-square. This very rare plant, of which photographs were shown, is new to East Anglia. As in the only other known British colony (in Buckinghamshire), a large number of flower heads were found eaten off; but some seed capsules mature. An equally important, and perhaps more surprising, extension of range was the discovery of *Trientalis europaea* in a boggy alder-birch coppice, also in Suffolk. This was shown by Dr. F. Rose (Bedford College, London), with a map of the

distribution of the species in Britain showing that the new locality is some hundred and fifty miles south of the nearest previously known station for this northern plant.

The flora of Rockall, which is about three hundred miles off the north-west coast of Scotland, was the subject of an exhibit by Miss Y. Chamberlain (British Museum (Natural History)). As a result of collections made from near the base of the rock by Charcot in 1921, and from the upper parts by James Fisher on September 18 last, twenty-one plant species are now known. These include one lichen (*Verrucaria* sp.), the remainder being algae. No flowering plants are to be found on this sea-swept and isolated rock.

Miss M. E. Bradshaw (Durham College) showed large-scale distribution maps of some *Alchemilla* microspecies in Teesdale and other valleys. These were plotted on a grid of 0·2 km. and showed interesting correlation with roadsides and fields used by grazing animals. A. C. Jermy (University College, Leicester) illustrated the distribution of *Luronium natans*. This was recorded from Ellesmere, in Shropshire, early in the nineteenth century and spread from Blake's Mere to the Shropshire Union Canal. It is still spreading in the Manchester, Stafford and Montgomery areas along the canals. Other localities are lakes, some of which are isolated in mountain districts, and it is suggested that waterbirds as well as water-carriage may be agents in its dispersal. Another aquatic was shown by Miss E. J. Gibbons and J. E. Lousley, who exhibited *Alisma gramineum*. This is already known from a lake in Worcestershire where it grows in shallow water with flowers, fruits and leaves usually above the surface. In September, Miss Gibbons discovered the species near Spalding in Lincolnshire, and subsequent investigation showed that it occurs in four rivers and drains. The plant there is completely submerged—even the fruits being well below the surface of the water—and very different superficially from the Worcestershire form. The occurrence of the species in Lincolnshire fits in well with the known Continental distribution and establishes it as an undoubted native in Britain.

Dr. C. D. Pigott (Sheffield) illustrated the distribution of the native race of *Polemonium coeruleum* on black humus-rich soils on ledges of limestone cliffs or screes in the Pennines and Cheviots. Transplant experiments suggest that the moisture content of the soil is critical. Its presence in widespread localities during late-glacial times has been confirmed repeatedly, and it is now known to have persisted through the post-glacial. Dr. E. M. Evans (Nature Conservancy) provided an exhibit on the distribution and ecology of *Primula farinosa*. It is found in short turf grassland of dry soils, in *parvocaricetum* of flushed soils, and in fen, and its tolerance of this wide range of habitats can be explained by the theory that a high water-table is required for maximum development. An interesting study of the changes which have taken place in the flora of a small area in the course of a century was provided by O. Polunin (Charterhouse). He compared the 702 species recorded by J. D. Salmon for the Godalming district in 1849 with the 1,016 species known in 1955. During this period there has been a great decline in arable land and big increase in built-up areas, roads and paths. Alien plants form a larger proportion of the present flora, and a few species have become extinct during the period. Comparisons of this kind can make a valuable contribution to our knowledge of the changes which are taking place in the British flora generally.

Several exhibitors showed plants which are likely to prove of importance as additions to the list of British species. One of the most interesting of these is a *Sparganium*, noticed in substantial numbers this autumn along two to three miles of the banks of the Thames near Oxford; this was exhibited by M. D. Gwynne (Oxford). It has large fruits, of which a big proportion are two-seeded, and was at first thought to be a polyploid form of *Sparganium ramosum* ($2n=30$); but it has been found to have about the same chromosome number. Of species already described, it seems to be near the North American *S. eurycarpum* Engelm., but further study is required before it can be named. W. M. Baron and R. Kemp (Oxford) showed the grass *Nardurus maritimus* from recent collections in Berkshire, Oxfordshire and Hampshire and gave some of the previous records with maps showing the British and Continental distribution. From the time it was first noticed in Lincolnshire in 1903 [3], its status has been in dispute; but our increased knowledge of the species suggests that in calcareous grassland it may well be native. The inland *Armeria* exhibited by Miss E. J. Gibbons and J. E. Lousley was first recorded from near Grantham in 1726 [3], and there are many eighteenth-, nineteenth- and twentieth-century notices over a wide area of the old 'Lincoln Heath' in Lincolnshire and Leicestershire. In spite of the existence of supporting specimens, some botanists have regarded the inland occurrence of the usually maritime thrift as so improbable that the records have been dismissed as errors or introductions. In fact, there seems no real reason to doubt that the plants are native, and it was suggested that specimens gathered at Ancaster this year (and probably those at the other places) are *A. elongata* (Hoffm.) Koch, which occurs inland on sandy heaths over much of northern central Europe. The taxonomic rank of this plant is uncertain, and for the time being it should perhaps be treated as a variety of the 'Atlantic' *A. maritima*, which is a common coastal plant. An exhibit provided by the Department of Botany of the British Museum (Natural History) included specimens of plants of which accounts had appeared in *Watsonia* or the *Proceedings* of the Society during the past year.

One of the most interesting exhibits showing the important contribution which breeding experiments can make to taxonomic research was provided by M. Cole (Southampton). *Chenopodium album* and *C. reticulatum* are easily distinguished by the markings on their seed-coats, and they have been treated as separate species; but Mr. Cole has shown that the seed-coat markings on any particular plant are determined by the male pollen parent (xenia) and are therefore not a reliable guide to taxonomic status. J. P. Savidge (Liverpool) exhibited *Callitriche platycarpa* as a distinct species in Britain. His observations confirm recent work in the Netherlands [4] that this is quite distinct from *C. stagnalis* in both chromosome and morphological characters. He has noticed at least nine ecological forms, varying mainly in the form of the leaves, and the majority of old records and herbarium sheets of *C. palustris* (*C. verna*) and *C. polymorpha* in Britain can be referred to this species. J. A. Ratter (Liverpool) demonstrated morphological criteria in the *Dryopteris spinulosa* complex. He showed that epidermal and spore characters readily separate *D. spinulosa* and *D. dilatata*. N. M. Pritchard (Oxford) exhibited forms

of *Gentianella campestris* in connexion with biometric analysis and cultural experiments being undertaken to ascertain if *G. baltica* is distinct from *G. campestris*, and if so, whether *G. campestris* forms a uniform group. Dr. E. F. Warburg (Oxford) showed forms of *Sedum forsterianum* and its allies which he has under cultivation, while B. N. Bowden (also of Oxford) illustrated the differences in the stomata between *Sesleria coerulea* and the British *S. varia* with a map showing doubtful as well as the accepted records of the latter in Britain. J. G. Packer (University College, Leicester) had a critical review of the criteria used for distinguishing the genus *Sieglingia*, in which he concluded that the relationship between *Danthonia calycina* and *Sieglingia decumbens* is one of species and not of genus. J. Rossiter (Oxford) showed specimens of *Ranunculus acris* and *R. bulbosus* which he had had in cultivation from Teesdale and Durham, and suggested that they included two ecotypes in each case. P. M. Benoit showed two forms of *Spartina townsendii* that he had found on mudflats near Barmouth Junction station, one of which had anthers only 5–7 mm. long, incompletely exserted, or exserted on short filaments, with small imperfect pollen grains and the styles small. This more slender plant is perhaps male-sterile, and was compared with a stouter form with anthers 8–11 mm. long exserted on long filaments with the pollen fully formed. P. D. Sell (Cambridge) and Dr. C. West exhibited a series of critical *Hieracia* and suggested that a long list of names in current use are synonyms of a single species.

It has already been shown that two species have been confused as greater bindweed—the native *Calystegia sepium* and the introduced *C. sylvestris*[5], which is more common in many districts. To these, an exhibit by Dr. S. M. Walters (Cambridge) and Prof. D. A. Webb (Trinity College, Dublin) added a third, the pink-flowered *C. dahuricus* Herbert apud Sims, which can be distinguished by the narrow leaf-shape and hairy winged petioles, and is widespread. G. Halliday (Cambridge) showed how another alien, *Arenaria balearica*, has been recorded from numerous widespread localities in Britain. As long ago as 1861 observations of this plant in Scotland aroused heated argument[6], and in 1908 it was remarked that it was "gradually making its way into our flora"[7]. To describe *Hieracium spraguei* as an 'endemic alien' would appear to be a contradiction in words, but, so far as our knowledge goes, this is a true statement of the position. Pugsley in 1948[8] described the species as new to science based on a plant found by Dr. T. A. Sprague in Buckinghamshire near Chorley Wood in 1923 and 1925. Despite careful search by several botanists, it could not be refound until R. F. Turney, who showed it at the exhibition, sent to Kew specimens collected by Mrs. A. T. Peppercorn in 1951. They have now found it in five localities in Buckinghamshire and one in Hertfordshire, but although the species is undoubtedly an alien in Britain, its native country is still unknown.

Mrs. B. H. S. Russell exhibited herbarium specimens and a drawing of *Dichondra repens*, a plant widespread both in the tropics and some temperate countries, which she had found established on dunes near Hayle, Cornwall. Miss C. M. Goodman showed a most interesting series of alien grasses found in fields in Worcestershire where their seeds had been introduced in wool 'shoddy'.

From the library of the Department of Botany of the British Museum (Natural History) was an exhibit of original drawings for Sowerby's "English Botany" for comparison with the copper-plate engravings of the first edition and lithographs of the third. From the same library came manuscripts of Wolley-Dod's "Flora of Sussex", Rea's "Botany of Worcestershire" (with the published works for comparison), Benbow's "Floras of Uxbridge and District and of Middlesex", and Trimen's annotated copy of Brewer's "Flora of Surrey". Mrs. H. N. Clokie (Oxford) showed specimens and manuscripts throwing new light on Dillenius and John Sibthorp. It seems that the types for Dillenius's new species in the third edition of Ray's "Synopsis" are likely to be found among Sherard's specimens rather than in the Dillenian Herbarium, most of the material of which was evidently collected after publication of the "Synopsis"[9].

Other exhibits included coloured photographs of some British plants by K. Le Sueur, an interesting photograph of *Ophrys fuciflora* believed to have been found in the Cotswolds, with an account of the circumstances by C. Thomas, records from the Lleyn Peninsula by Dr. A. P. Conolly, the stolon system of *Glaux maritima* by F. N. Hepper and Euphrasias in southern England by P. F. Yeo. J. E. Lousley

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[2] Woodruffe-Peacock, E. A., *The Naturalist*, 408 (1903).
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[6] Sim, J., *et al.*, *Phytologist*, **5** (N.S.), 32, 46, 127 (1861).
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INTERNATIONAL ANALOGY COMPUTATION MEETING

THE Société Belge des Ingénieurs des Télécommunications et d'Électronique organized last year a series of lectures and colloquia on the various aspects of analogy computation. These meetings, held on a local basis, aroused so much interest and seemed to lead to such fruitful discussions that the Society decided, in collaboration with the Société Belge des Électriciens and the Société Belge des Mécaniciens, to organize a larger international conference on this subject. This meeting was arranged for the period September 26–October 2 in Brussels, and was attended by four hundred scientists and engineers from seventeen countries. Apart from many Belgian participants, strong delegations went from the United States, France and Great Britain, and among the foreign guests were several scientists from the U.S.S.R. and from Poland. In conjunction with the scientific sessions, an exhibition of analogue computing equipment and of many interesting and novel applications was held.

The great number of papers submitted for reading (one hundred and one) made it necessary to conduct two parallel sessions, and several additional discussion meetings in smaller circles took place. To preserve the unity of the conference, the following invited survey papers were given before the whole audience on succeeding days, before splitting up for the specialist parallel sessions: "Les analyseurs différentiels électroniques", by M. F. H. Raymond; "Electrical network analysers", by Mr. E. L. Harder; "La méthode d'analogie rhéoélectrique, ses possibilités et

ses tendances", by Prof. L. Malavard; "The mechanical differential analyser, recent developments and applications", by Mr. J. G. L. Michel; "Resistance-network analogues", by Dr. G. Liebmann; "Pédagogie concrète du calcul fonctionnel linéaire", by Prof. J. Brodin; and "Special computers", by Prof. H. Wallman. About 50 per cent of all contributions dealt with various aspects of electronic analogue computers, including differential analysers, simulators, etc., about 30 per cent with electrical analogues, such as electrolytic tanks and resistance-networks and their recent applications, and the remaining 20 per cent with mechanical differential analysers and various special-purpose computers. The review papers and the original communications, together with the discussions on these papers, will be published in full as Proceedings of the International Analogy Computation Meeting, Brussels, 1955, and its editors hope that the volume will be available at an early date.

It was decided during the meeting to form an International Association for Analogy Computation (Association Internationale pour le Calcul Analogique), and the chairmen of the various sessions, representing a good international cross-section, were asked to act as members of the organizing committee. The purpose of the new International Association for Analogy Computation is the furthering of this field by the organization of national and international scientific meetings, and the publication of a multi-language bulletin or periodical devoted to the scientific and engineering basis of analogue computers and to their steadily growing applications. Collaboration will be sought with existing organizations in the fields of electrical and mechanical engineering, and with those working with other computing techniques. The basic organization of the new Association will be in the hands of its first elected president, Prof. J. Hoffmann, and his colleagues at the Université Libre, Brussels.

This first international analogy computation meeting, bringing together people from many countries, was considered by all participants a very stimulating event, and the excellent organization of the meeting by the Société Belge des Ingénieurs des Télécommunications et d'Électronique and the great hospitality enjoyed will be remembered by all.

G. LIEBMANN

CHEMISTRY AND PHYSIOLOGY OF PHOSPHOLIPIDS

SYMPOSIUM IN ONTARIO

DURING October 12–13, some hundred and twenty scientific workers gathered at the University of Western Ontario, London, Ontario, to attend a symposium on phospholipids sponsored by the Biochemistry Division of the Chemical Institute of Canada. The success of the meetings, planned by Prof. R. J. Rossiter and members of the local committee of the Institute, was attested by the enthusiastic response of all participants. The papers and succeeding discussions will be published in full in the *Canadian Journal of Biochemistry and Physiology*.

The first part of the symposium, with Dr. A. M. Wynne (University of Toronto) in the chair, was entitled "Chemistry of Phospholipids" and dealt with current advances in knowledge of the structure and properties of the phospholipids. Dr. Erich Baer (Toronto) outlined the elegant synthetic methods used by his group for preparing optically pure α- or β-isomers of glycerophosphoric acid, glycerylphosphorylcholine, phosphatidic acids, lecithins, glyceryl-phosphorylethanolamine, glycerylphosphorylserine, and phosphatidyl serine. He also described the 22-step preparation of the first synthetic lipopeptide, L-α-(distearoyl)-phosphatidyl-L-serylglycylglycine. Finally, he reported on the first synthetic preparation of a fully unsaturated lecithin, L-α-dioleyllecithin. Of particular interest is the ability of this substance to render a number of polar compounds soluble in organic solvents, and its property of high stability to atmospheric oxidation. Dr. Baer emphasized the consistency with which the L-configuration and α-structure appear in natural glycerolphosphatides. In discussing Dr. Baer's paper, Dr. C. S. McArthur (University of Saskatchewan) commented on the attempts to prepare lecithins from L-α-glycerylphosphorylcholine by other methods. He also pointed out the possibilities of appreciable phospholipid losses during the dehydration of tissue with acetone prior to lipid extraction.

Drs. J. Folch and F. N. LeBaron (Harvard Medical School) critically reviewed the current state of knowledge of the chemistry of phosphoinositides. It was pointed out that the common feature of this class of lipids is the presence of meso-inositol, phosphoric acid and fatty acids. In some cases carbohydrates or amines are present and often glycerol. The five phosphoinositide preparations discussed include soybean lipositol, brain diphosphoinositide (the only member of the group from which inositol diphosphate has been obtained rather than the usual monophosphoric acid ester), peanut glyceroinositophosphatide, and wheat germ and cardiac muscle glyceroinositophosphatidic acids. Dr. Folch reported on the hydrolysis studies which have been carried out, the difficulties of obtaining uncontaminated preparations, and the appearance of inositol in other lipid complexes, and he emphasized the need for further structural studies. Dr. C. C. Lucas (Toronto) pointed out that the ubiquitous occurrence of inositol in biological material suggests a role as an essential component, and this is strengthened further by the observed lipotropic action of inositol.

The recent progress in the chemistry of sphingolipids was comprehensively reviewed by Dr. H. E. Carter (University of Illinois). He outlined the classical evidence for relative positions of functional groups on sphingosine and described his synthesis of tribenzoyl-D-*erythro*-dihydrosphingosine, which has properties conforming to those of the tribenzoyl derivative of the naturally occurring material. The application of infra-red techniques to establish the *trans*-structure of the double bond was mentioned, and the structure of sphingosine has finally been proved to be D-*erythro*-1, 3-dihydroxy-2-amino-4-*trans*-octadecene. This would appear to be confirmed by the recent reports of the synthesis of sphingosine. Dr. Carter pointed out the difficulties encountered in establishing the *erythro*-configuration of sphingosine as it occurs in cerebrosides due to possibilities of inversion during hydrolysis. However, he showed that the analogous compound, phrenosine, contains sphingosine bearing the *erythro*-configuration, and he gave further information regarding cerebrosides and cerebroside sulphuric ester, although the configuration of the galactosidic bond remains unsolved. The steps which have led to the elucidation of the structure

of sphingomyelin were then described, and mention was made of the complex glycosides of sphingosine, including gangliosides, hæmatosides, globosides, strandin, and polycerebrosides. Most of these glycolipids contain hexosamine or neuraminic acid. Finally, Dr. Carter reported the finding of phytosphingosine in corn phosphatides and preliminary evidence favouring the view that corn phosphatides contain phytosphingosine as phytosphingolipids rather than as simple phytocerebrosides.

Dr. J. F. Berry (Western Ontario) re-emphasized the importance of the techniques presented by Dr. Carter for approaching the characterization of sphingolipids and the nature of the complex bonds in proteolipids and lipopeptides. He described preliminary studies on the successful paper-chromatographic separation of intact tissue phospholipids, and stressed the importance of these techniques in identifying and purifying new phospholipids.

The second part of the symposium, with Dr. W. R. Bloor (University of Rochester, New York State) in the chair, was devoted to "Metabolism and Function of Phospholipids". Dr. E. P. Kennedy (University of Chicago) introduced his account of the biological synthesis of phospholipids by emphasizing the contribution made by the advent of isotope tracer techniques and their application to studies in cell-free enzyme preparations. He reviewed the evidence pointing to L-α-glycerophosphate as a precursor to phospholipids, a point demonstrated by the incorporation into phospholipids of glycerophosphate labelled with phosphorus-32. Dr. Kennedy's group provided the next logical step by the isolation and partial purification of a rat liver enzyme, glycerokinase, which synthesizes L-α-glycerophosphate from adenosine triphosphate and glycerol. Dr. Baer's suggestion that natural glycerophosphatides are of the L-α-configuration was given support by this finding and by the observation that only the L-α-glycerophosphate can be incorporated into phospholipids. Kornberg's earlier work was reviewed, which demonstrated the activation of fatty acids to acyl-coenzyme A derivatives with adenosine triphosphate, and the attachment of these acyl-coenzyme A esters to L-α-glycerophosphate to form phosphatidic acid, the function of which was the subject of much discussion during the remainder of the symposium. Kornberg had earlier suggested that phosphorylcholine could be incorporated into lecithin by condensation with phosphatidic acid, inasmuch as the incorporation of a phosphorylcholine unit into lecithin was demonstrated. Dr. Kennedy's group has found that large amounts of adenosine triphosphate are necessary to accomplish this reaction in mitochondria. Further scrutiny reveals that the active co-factor is a cytidine triphosphate contaminant of the adenosine triphosphate preparation. Dr. Kennedy and his co-workers have demonstrated a condensation between cytidine triphosphate and the phosphorylcholine unit with the formation of cytidine-diphosphorylcholine, which was isolated chromatographically, estimated in tissues by isotope dilution techniques, and chemically synthesized. Labelled synthetic cytidine-diphosphorylcholine, as well as cytidine-diphosphorylethanolamine, have been shown to act as precursors for the isotope in phosphatidyl choline and phosphatidyl ethanolamine, respectively. Furthermore, tissue enzymes have been found that are able to synthesize the cytidine diphosphate bases. This reaction is reversible and is also completely specific for cytidine triphosphate and represents the first co-enzymatic role found for this nucleotide. Enzymes have previously been described that are able to phosphorylate choline or ethanolamine from adenosine triphosphate. Dr. Kennedy pointed out the bearing such metabolic pathways might have upon the biosynthesis of other phospholipids and on the lipotropic effect of choline.

Dr. G. C. Butler (Toronto), in discussing Dr. Kennedy's paper, raised the pressing point of the nature of the acceptor for phosphorylcholine. Phosphatidic acid, triglycerides and diglycerides are prominent among the suspected compounds. However, attempts to demonstrate any of these compounds as intermediates have met with failure.

Dr. L. E. Hokin (McGill University) presented the results of his studies on the metabolism of phospholipids *in vitro*, in which he has found that cholinergic drugs and pancreozymin in the pancreas, and acetylcholine and adrenalin in the salivary glands, all stimulate the secretion of protein. In each case, the high secretion of protein is accompanied by an increased incorporation of phosphorus-32 into the phospholipids. These studies were carried out with actively respiring tissue slices. The observed effects were only slight in homogenate preparations, and were not accompanied by changes in respiration or labelling of acid-soluble phosphorus compounds. Dr. Hokin has extended these studies to include guinea pig brain-cortex slices, where a similar stimulation of the incorporation of phosphorus-32 into phospholipids was obtained with acetylcholine. This was abolished in the presence of atropine. In both pancreas and brain slices, incubated with phosphorus-32 and glycerol labelled with carbon-14, acetylcholine stimulated primarily the incorporation of phosphorus-32 with little effect on the incorporation of carbon-14. This was taken to indicate an increased turnover of a phosphorus-containing portion rather than increased total synthesis of phospholipid. By mild alkaline hydrolysis of the lipid extracts and paper-chromatographic separation of the products according to the technique of Dawson, Dr. Hokin has demonstrated that acetylcholine maximally stimulates the incorporation of phosphorus-32 into phosphatidic acid and phosphoinositide in brain and pancreas. Appreciable effects were noted on phosphatidylcholine in brain and on phosphatidylethanolamine in pancreas.

Dr. R. J. Rossiter (Western Ontario) pointed out two additional physiological conditions, namely, starvation and cold stress, which produce changes in lipid labelling from one substrate and not from another. In these cases, phospholipid labelling from acetate-1-^{14}C is decreased, with no change in labelling from glycerol-1-^{14}C, glycine-2-^{14}C, or inorganic phosphorus-32. In addition, Dr. Rossiter gave details showing a greater incorporation of glycerol-1-^{14}C into the glycerol portion of phosphoglycerides than into the glycerol portion of phosphatidic acid. This supplies further evidence tending to negate the suggestion that phosphatidic acid might function as an acceptor of phosphorylated base.

Dr. J. M. R. Beveridge (Queen's University, Kingston, Ontario) reviewed the current views on the function of phospholipids and, among other functions, discussed their role as a structural element. Although there is little to support the notion that phospholipids act as intermediates in the resynthesis of triglycerides during fat absorption, it is considered that they are involved in this process in some manner.

Dr. Beveridge gave evidence contrary to the belief that phospholipids comprise a vehicle for the transportation of fatty acids, although he pointed out that the phospholipids as β-lipoproteins may play a part in the transport of neutral fat. Finally, he quoted from the literature in support of the theory that choline-containing phospholipids facilitate the oxidation of fatty acids. He emphasized that no single function of the phospholipids could be stated in a positive manner. Dr. O. F. Denstedt (McGill University) commented on the physico-chemical function of phospholipids at biological interfaces.

JAMES F. BERRY

MELTING OF SOLIDS

SYMPOSIUM IN OTTAWA

A SYMPOSIUM on melting, diffusion and related topics was held during October 24–25 at the National Research Council Laboratories, Sussex Drive, Ottawa, under the chairmanship of Dr. D. K. C. MacDonald. The meeting was held at the invitation of the Low Temperature and Solid State Physics Group of the Division of Pure Physics, National Research Council of Canada, for the purpose of bringing together scientists within easy reach of Ottawa interested in melting from the different points of view of chemist, geophysicist, metallurgist and physicist. Twelve lectures were given; fifty minutes was allotted to each, of which about twenty was reserved for questions and discussion. It was found that this schedule allowed each speaker time for an adequate exposition of his subject, while preserving the balance of lecture and discussion.

A contrast soon became apparent between the working concepts of the physicists and chemists and those of the metallurgists. The physicists and chemists tended to regard both solid and liquid as homogeneous down to atomic dimensions, and thought in terms of thermodynamics and statistical mechanics. Thus, in his introductory lecture, Dr. MacDonald discussed self-diffusion and melting, using the model of 'hole' formation in the crystal lattice, and outlined the evidence which suggests that melting occurs when the hole concentration has risen to the order of 10^{-3}. J. S. Dugdale (National Research Council) gave a comprehensive review of both experimental and theoretical work on the behaviour of the melting curve at high pressures. Two papers from Chalk River described investigations of structure and diffusion in liquids using slow-neutron diffraction: D. G. Henshaw and D. G. Hurst have determined radial distribution functions in liquid helium, which show marked increase in short-range order with increase of pressure; and B. N. Brockhouse has made some preliminary measurements of the energy distribution in neutrons scattered from liquids, data which, after suitable analysis, can give information about self-diffusion and time-dependent pair distribution functions in the liquid. J. A. Morrison (National Research Council) described experiments on surface melting in adsorbed layers of argon and nitrogen on substrates of titanium oxide, with an anomaly in specific heat becoming rapidly sharper as the thickness of the layer increased. The interpretation of these results was discussed by D. C. Patterson (University of Montreal), using an order–disorder model for melting, and later by the meeting at large.

W. B. Pearson (National Research Council) described experiments on dilute alloys illustrating the effects of lattice distortion upon melting temperatures. The other metallurgists were concerned to make plain the inhomogeneous nature of the melting process, making use of photographs of the melting and freezing interfaces in metals. A. Rosenberg (University of Toronto) showed that freezing in 'pure' lead takes place by lamellar growth, and that melting appears to be the same process in reverse; this was effectively illustrated in a film using suitable space and time magnification. J. W. Rutter (University of Toronto) described the freezing of impure metals and showed how the formation of impurity substructures depends upon the concentration of impurity, rate of freezing, and temperature gradient in the liquid. E. H. McLaren (National Research Council) has used precision (10^{-4} deg. C.) resistance thermometry for investigating the freezing and melting temperatures of zinc and tin, and has found that differences of freezing technique and thermal history can cause changes up to about 10^{-3} deg. C. In a brief, provocative talk, W. C. Winegard (University of Toronto) emphasized the difference of outlook of physicist and metallurgist and criticized the theories of the former for taking no account of the impurities and dislocations which are known to play an important part in melting. A lively discussion followed, profitable because the participants had already listened to uninterrupted expositions of each other's work.

Any doubts of the usefulness of even the crudest of fundamental theories was dispelled by R. J. Uffen (University of Western Ontario), who described how knowledge of the physics of condensed phases is used in attempts to deduce the composition and state of the Earth's mantle and core. For this purpose not nearly enough is yet known about the physics of high pressures, and bold extrapolations from laboratory pressures have to be made. The success of the symposium makes it probable that similar meetings will be arranged for the discussion of other subjects related to work in low-temperature and solid-state physics.

T. H. K. BARRON

CHEMICAL COMPOSITION OF PARTHIAN COINS

AN outstanding example of the value of accurate and complete chemical analyses in the investigation of ancient metals, when these are afterwards interpreted by an ingenious mind, is given in a monograph on the "Chemical Composition of Parthian Coins", by Earle R. Caley, published by the American Numismatic Society, New York (Numismatic Notes and Monographs, No. 129; 1955). The author has made a large number of analyses of Parthian silver and bronze coins not only for the major constituents but also for minor impurities. There is internal evidence that these are reliable, and much new light is thrown on a field of historical metallurgy concerning which knowledge has hitherto been most meagre.

An elegant piece of detective research has revealed, practically beyond doubt, the materials from which the debased silver coins of the King Orodes I (57–38/37 B.C.) were made. From analyses of silver coins of the highest fineness for the time, it is shown that

the 'pure' silver available might contain just over 99 per cent of silver and gold together (the presence of traces of gold in the silver was not recognized by early metallurgists) and perhaps 0·4 per cent of lead. Accepting this composition for the basis metal, the other impurities—tin, part or all of the lead, iron, nickel and, in one case, zinc—will, in the main, have come in with the copper when this and the silver were melted together. It is possible, therefore, to calculate the composition of the copper alloy used.

From such calculations it is clear that two different materials have been employed at different times, for the drachm and for the tetradrachm, and presumably at different mints. In one case the alloy appears to have been prepared from the 'pure' silver and very impure, but virgin, copper, the average analysis of that used in the manufacture of the drachms being: copper, 95; tin, 1·7; lead, 2·8; iron, 0·1; and nickel, 0·1. The copper used for the tetradrachms was of much better quality, being approximately: copper, 99; tin, 0·3; lead, 0·5; iron, 0·1; and nickel, 0·1; which in all probability was of the highest purity then available to the mint. The marked difference in these two analyses would suggest that the drachms and the tetradrachms were struck at different mints, which were possibly a considerable distance apart.

In the other case, there is consistent evidence that a bronze was employed the composition of which was very approximately: copper, 91; tin, 5·5; lead, 3; iron, 0·1; and nickel, 0·1. Comparison of this result with analyses of the earlier Parthian bronze coins shows that the two compositions are in many cases not greatly different either in the major elements present or in the content of impurities. It is suggested, therefore, that the bronze used for preparing the debased alloys was obtained by melting down bronze coins of the earlier Parthian kings. In some cases the amount of lead present is in excess of that likely to be present in the silver and that introduced by the bronze, and it may be, therefore, that in such coins a relatively small amount of lead was deliberately added as such.

F. C. Thompson

NATIONAL RESEARCH COUNCIL OF CANADA

REPORT FOR 1954–55

THE thirty-eighth annual report* of the National Research Council of Canada covers the year ended March 1955, and comprises, besides the president's report, the financial statement and the balance sheet and annual statement of Canadian Patents and Developments, Ltd. The president's report notes that in 1954 the National Research Council provided 2·5 million dollars in 410 awards and 263 scholarships for fundamental research at the universities, and that since the end of the Second World War the Council's support to the universities has increased five-fold. The Council's own scientific staff numbered 548, with 711 technicians and 775 engaged in general service and administrative, as well as about a hundred postdoctorate Fellows. Technical inquiries from Canadian industries numbered about seven thousand five hundred, and the president stresses the value of the work of the twenty-eight associate committees in dealing with scientific and technical problems of national scope.

In an effort to reduce the surface drying of foodstuffs, the Division of Applied Biology has obtained relative humidities approaching saturation by cooling an experimental room indirectly through a jacket of cold air, and recent studies by the Division have shown that the grey discoloration of processed pork occurs much more rapidly in the muscle pigment, myoglobin, than in the blood pigment, hæmoglobin. Investigations of the frozen storage of living cells and small organisms have shown that glycerol reduces freezing damage by changing the pattern of ice-formation. Studies of the carbohydrate composition of various grains, woods and marine algæ have shown that in most plant tissues large quantities of hemicellulose and other complex sugars are associated with cellulose.

The scientific interests of the Maritime Regional Laboratory have been broadened considerably, and a dryer capable of operating on half-ton batches has been designed and constructed for studies of the drying of seaweeds and similar material. Nutritional tests on dried dulse and rockweed meals indicated that the meals compared favourably with casein and were superior to gelatin or soybean in regeneration of liver protein. A method has been developed for determining the presence of carrageenin in seaweeds, and a study of the cause of the flakiness of cod fillets was commenced. At the Prairie Regional Laboratory, Saskatoon, work was continued on the utilization of agricultural materials, including the utilization of straw for pulp, and an investigation on the production of lysine by fermentation. A new fermentation has been developed for *d*-arabitol, glycerol and erythritol. A study of contributory factors in elevator dust explosions points to particle size as the most important factor, only those fractions which pass through a 150-mesh screen being potentially dangerous in initiating explosions.

In the Division of Applied Chemistry, special attention was given to the corrosion in automotive cooling systems by ethylene glycol and the corrosion of iron in aqueous solutions, while studies of the adsorption and desorption of detergents by textiles, using radioactive tracer techniques, have led to a better understanding of detergent action and indicated possibilities for obtaining higher efficiencies in laundering. Work on the direct oxidation of ethylene to ethylene oxide has led to basic studies on the phase behaviour and magnetic susceptibilities of oxidation catalysts, the kinetics of the photochemical oxidation of hydrocarbons, the catalytic polymerization of ethylene and physical adsorption at gas–solid interfaces. Promising results were obtained in a new drying technique for contacting solids and fluids.

The Division of Pure Chemistry continued its investigations of alkaloids and also work on the quantitative description of solvolytic reactions of aromatic and aliphatic sulphonic acids in water and alcohols. Studies of infra-red spectra have been applied to the identification of small amounts of steroid hormones and metabolites isolated from natural sources, and work on free radicals has been extended to the liquid and solid states. A method has been developed in the Molecular Spectroscopy Section for obtaining standard Raman intensities, the sum of which is useful in determining the structure

* Thirty-eighth Annual Report of the National Research Council of Canada, 1954–55, including the Annual Report of the Canadian Patents and Development, Ltd. Pp. 44. (N.R.C. No. 3607.) (Ottawa: National Research Council, 1955.)

of petroleum hydrocarbons; and in a study of the extent to which the properties of very small solid particles differ from those of bulk solids, besides effects due to the small dimensions, effects attributable to the structure of solid surfaces have been found.

In the Division of Physics, the Applied Physics Branch has provided a common dosage standard for X-radiation at cancer clinics throughout Canada, has made a significant contribution to Canadian mapping methods, and has completed a mutual inductance on which the Canadian ohm will be based, a highly precise temperature scale extending over most of the international scale, and the reproduction of the standard of brightness through the brightness of melting platinum. A major effort in the Interferometry Section was the study of new wave-length standards with the view of basing the international metre, and hence the Canadian yard, on a wave-length. Good progress was made on an analytical method of bridging, and the usefulness of a radar altimeter and of combined vertical and oblique aerial photographs was also demonstrated. The Pure Physics Branch reports a considerable advance in the knowledge of the relative ionizing effects of particles of different energies, in the energy-range of billions of electron volts, and the same photographic plate technique has been used to study and identify rare types of mesons produced by cosmic rays. The outstanding developments in the Solid State Physics Group have been in studying 'anomalous' electron behaviour in metals at low temperatures, and the resistance minimum in copper was studied in greater detail in an attempt to understand its origin. Well-resolved absorption and emission spectra of the molecules O_2, NO, NO^+, HCN, CO and CN in the vacuum ultra-violet have been obtained with the 3-m. vacuum spectrograph, and using the same instrument the absolute wave-length of the Lyman alpha-line of deuterium has been determined with considerable precision. The structures of pyrobelonite and brackebuschite (vanadium minerals), codeine hydrobromide dihydrate, lindgrenite (a copper molybdate mineral) and potassium dithionate have been determined in the X-Ray Diffraction Laboratory.

The Division of Building Research continued to develop steadily, and, in co-operation with the Central Mortgage and Housing Corporation, steady progress was made in the improvement of technical housing standards and designs, consistent with every practicable reduction in true costs. A completely revised National Building Code of Canada was issued in June 1954, and the research into fire fatalities is already yielding significant results. Jointly with the Meteorological Division of the Department of Transport, the Division also published the first Climatological Atlas of Canada, the result of two years work by its own climatologist.

Much of the work of the Division of Mechanical Engineering continued to be devoted to defence, but in the Hydraulics Laboratory activity was concentrated on projects related to the St. Lawrence Seaway development. Extended work was carried out on the suitability of Western Canadian fuel oils for industrial gas turbines, and the facilities of the Fuels and Lubricants Laboratory were being extended to permit qualification tests of heavy-duty automotive and marine oils, hypoid gear lubricants, lubricating greases, and hydraulic and brake fluids. The investigation of aircraft icing in flight was terminated, but the icing project is continuing with an investigation of the icing of helicopters, while icing protection studies have also been made on radar components, gas turbine components, radomes and icing instruments.

About half the work of the Radio and Electrical Engineering Division has continued to be concerned with defence; but besides the microwave position-fixing system for inshore survey operations, the Division has designed a microwave system to operate combined automatic-light and fog-alarm stations which cannot be easily or economically controlled by submarine cable, and two installations have been completed. Considerable progress has been made in developing an instrument making an electronic inspection for flaws of high-quality paper while it is being manufactured. The use of silica in place of germanium as the active element in transistors was being investigated, and theoretical studies of electron-tube physics have led to the development of a new detector for microwave energy and to a new laboratory method of measuring the maximum electron emission from cathodes. An experimental microwave radio link has been established between Ottawa and Toronto to study the scattering of microwave signals beyond the horizon, caused by turbulence in the atmosphere, and, besides daily observations of radio emission from the Sun on a wave-length of 10·7 cm., three electronic musical instruments were being developed.

The Division of Medical Research made 151 grants during the year and granted eight senior and sixteen ordinary research fellowships. About two-thirds of the grants were for a continuation of researches.

SELECTIVITY OF ENZYME-ACTIVATED NITROGEN MUSTARDS

By P. HEBBORN and Prof. J. F. DANIELLI

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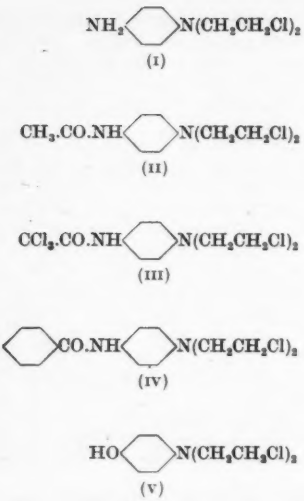
IN chemotherapy, in general one of the outstanding problems is to obtain drugs which will have a much greater effect upon the cells which are intended to be the target for the drug than upon other cells. In the chemotherapy of tumours, this problem is particularly difficult to solve because tumour cells closely resemble many normal cells, to which extensive damage cannot be tolerated. In theory, the selectivity of a drug can be increased by administering it as a derivative, the action of which is contingent upon one or more cellular variables[1]. The more variables involved in eliciting the action of a drug, the greater will be its selectivity.

We have made a preliminary investigation of this theory, starting from the aromatic nitrogen mustards, such as (I), which have been developed at the Chester



Beatty Research Institute. The action of this compound, and a number of its derivatives, has been examined by intramuscular injection into Wistar albino rats bearing the Walker rat sarcoma 256. The derivatives were compounds (II), (III) and (IV). The cytotoxic action of nitrogen mustards is believed to be caused by ionization of a chlorine atom from a β-chloroethyl group to give a highly reactive carbonium ion, $R.CH_2CH_2^+$. It has been shown, particularly by the work of Haddow, Kon and Ross[2] and Ross[3], that in the derivatives of phenyl di-(β-chloroethyl) amine the rate of formation of carbonium ions is modified by substitution in the benzene ring. The general conclusion has been that derivatives with a high rate of formation of carbonium ions have a pronounced inhibitory effect on tumour growth, whereas derivatives with a low rate of ionization have no effect. Compound (I) has a very high rate of ionization, whereas in (II), (III) and (IV) the rate of ionization is greatly reduced. Thus the general toxicity, and action upon tumours, of (II), (III) and (IV) should be much less than with (I), except in the case of cells which contain enzymes capable of liberating (I) from the derivatives: that is, the action of (II), (III) and (IV) should be restricted to those cells which contain enzymes capable of liberating (I) by hydrolysis of the CONH group. Thus in theory these compounds are provided with the equivalent of a selective proximity fuse.

To study this theory, we have investigated (*a*) the toxicity of the compounds to rats not bearing tumours, (*b*) the cause of death with the different compounds, (*c*) the action upon the Walker rat sarcoma 256, and (*d*) the enzyme content of the tumour and certain organs of the rat.

The results are summarized in Table 1. The rate of hydrolysis, in the second column, determined by Dr. W. C. J. Ross, gives a measure of the rate of formation of carbonium ions. The third column contains *LD*50 values, as a measure of toxicity. The detoxication caused by acylation is very striking. The trichloracetyl derivative had less than one two-hundredth of the toxicity of the parent compound. The decreases in toxicity are much greater than can

Table 1

Drug	Rate of hydrolysis per cent (Ross)	*LD*50 (mgm./100 gm. rat)	Action on tumour	Enzyme units/gm. tissue	
				Liver	Tumour
(I)	> 100	0·6	(+)		
(II)	42	4·8	++	1·8	0·29
(III)	13	> 100	++	40	0·36
(IV)	40	35	−	∿ 35	0·05

be accounted for by the changes of rate of hydrolysis.

Despite the large variations in toxicity, the cause of death was probably the same for all four compounds. Before death the abnormalities were a progressive loss of weight (up to 30 per cent), diarrhœa which was occasionally hæmorrhagic, an erythematous condition of the nose, muzzle and eye regions, a general weakness of the rat associated with apathy, laboured breathing, coldness and, finally, coma.

Post-mortem observations indicated that the gut was affected to the greatest extent. Macroscopically, this was marked by a loss in tone and distension due to fluid and gaseous contents. The spleen and body-fat were reduced.

Cytological examination showed that there was an absence of mitosis in the gut and a drastic reduction in the size of the villi in rats subjected to drugs (I) and (II), whereas the gut of rats subjected to drug (IV) showed no histopathological symptoms.

The action of a cytotoxic agent upon a tumour may be to cause regression, to inhibit further growth, to slow the rate of growth, or negligible. The action of compounds (I)–(IV) was tested upon tumours which had grown to a volume of 5–10 ml. Each compound was given in a daily dosage of one-third to one-tenth of the *LD*50, for up to eight days. With the parent compound (I), the rate of growth of the tumour was reduced and there was a considerable fall in body-weight. With (II) and (III) regression occurred, and there was a fall in body-weight. Compound (IV) had no action upon either the tumour- or body-weight. There is no correlation between either toxicity, or rate of hydrolysis, and action upon the tumour.

When tested for enzyme able to hydrolyse the amide linkage in compounds (II)–(IV), the different organs of the rat differed markedly. For example, with the acetylamino-group, muscle had little activity, whereas kidney, liver and intestine had marked activity. The tumour activity was marked towards the acetylamino- and trichloroacetylamino-groups, and negligible towards the benzoylamino-group. There is a correlation between ability to cause regression and presence of a significant amount of activating enzyme in the tumour.

The results obtained support the view that the selectivity of a cytotoxic compound can be increased by converting it to a derivative from which the parent compound can be released by enzyme activity. With the three derivatives used here, in two cases the selectivity for tumour cells was notably increased, and in the other case equally decreased: these differences were correlated with presence (or absence) of activating enzyme. A similar correlation has been obtained with the corresponding derivatives of the phenolic mustard (V). It is interesting that such considerable differences exist between derivatives obtained with such simple acylating agents: with more complex inactivating agents a higher degree of selectivity may be expected.

The nitrogen mustards act most strikingly upon cells in which growth and division are rapid. The selectivity of the derivatives studied here is based on at least two cellular variables—growth-rate and enzyme content. It seems probable that a further increase in selectivity could be introduced by using inactivating agents introducing dependence upon yet a third variable. For example, acylation of (I) with an amino-acid might be expected to add dependence upon active transport of amino-acids. Investigations of this nature are now being made, with assistance provided by the British Empire Cancer Campaign.

We are indebted to Boots Pure Drug Co., Ltd., for the gift of compounds (I), (II) and (III), to Dr. W. C. J. Ross, who synthesized compound (IV) for us, to Mr. J. A. Marsh for help and advice with the tumour tests, and to Prof. A. Haddow and Dr. L. N. Owen for advice on many points. One of us (P. H.) has held a studentship of the Medical Research Council while carrying out this work. [Oct. 10

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[3] Ross, W. C. J., "Advances in Cancer Research", **1**, 397 (1953).

CORRELATION BETWEEN PHOTONS IN TWO COHERENT BEAMS OF LIGHT

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AND
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Services Electronics Research Laboratory, Baldock

IN an earlier paper[1], we have described a new type of interferometer which has been used to measure the angular diameter of radio stars[2]. In this instrument the signals from two aerials A_1 and A_2 (Fig. 1*a*) are detected independently and the correlation between the low-frequency outputs of the detectors is recorded. The relative phases of the two radio signals are therefore lost, and only the correlation in their intensity fluctuations is measured; so that the principle differs radically from that of the familiar Michelson interferometer where the signals are combined before detection and where their relative phase must be preserved.

This new system was developed for use with very long base-lines, and experimentally it has proved to be largely free of the effects of ionospheric scintillation[3]. These advantages led us to suggest[1] that the principle might be applied to the measurement of the angular diameter of visual stars. Thus one could replace the two aerials by two mirrors M_1, M_2 (Fig. 1*b*) and the radio-frequency detectors by photo-electric cells C_1, C_2, and measure, as a function of the separation of the mirrors, the correlation between the fluctuations in the currents from the cells when illuminated by a star.

It is, of course, essential to the operation of such a system that the time of arrival of photons at the two photocathodes should be correlated when the light beams incident upon the two mirrors are coherent. However, so far as we know, this fundamental effect has never been directly observed with light, and indeed its very existence has been questioned. Furthermore, it was by no means certain that the correlation would be fully preserved in the process of photo-electric emission. For these reasons a laboratory experiment was carried out as described below.

The apparatus is shown in outline in Fig. 2. A light source was formed by a small rectangular aperture, 0·13 mm. × 0·15 mm. in cross-section, on which the image of a high-pressure mercury arc was focused. The 4358 A. line was isolated by a system of filters, and the beam was divided by the half-silvered mirror M to illuminate the cathodes of the photomultipliers C_1, C_2. The two cathodes were at a distance of 2·65 m. from the source and their areas were limited by identical rectangular apertures O_1, O_2, 9·0 mm. × 8·5 mm. in cross-section. (It can be shown that for this type of instrument the two cathodes need not be located at precisely equal distances from the source. In the present case their distances were adjusted to be roughly equal to an accuracy of about 1 cm.) In order that the degree of coherence of the two light beams might be varied at will, the photomultiplier C_1 was mounted on a horizontal slide which could be traversed normal to the incident light. The two cathode apertures, as viewed from the source, could thus be superimposed

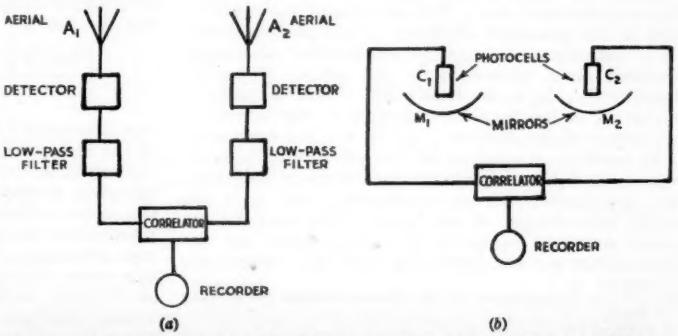

Fig. 1. A new type of radio interferometer (*a*), together with its analogue (*b*) at optical wave-lengths

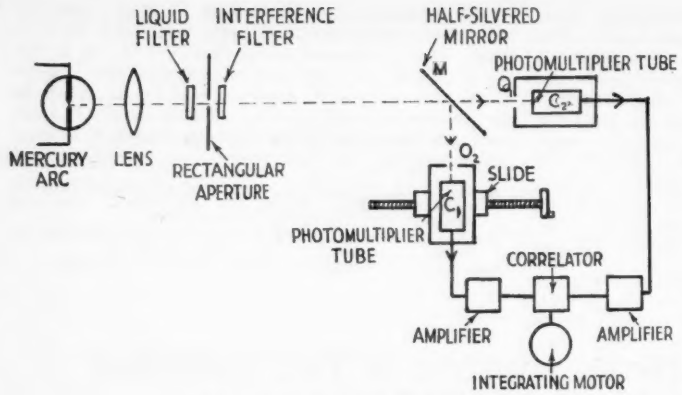

Fig. 2. Simplified diagram of the apparatus

or separated by any amount up to about three times their own width. The fluctuations in the output currents from the photomultipliers were amplified over the band 3–27 Mc./s. and multiplied together in a linear mixer. The average value of the product, which was recorded on the revolution counter of an integrating motor, gave a measure of the correlation in the fluctuations. To obtain a significant result it was necessary to integrate for periods of the order of one hour, so very great care had to be taken in the design of the electronic equipment to eliminate the effects of drift, of interference and of amplifier noise.

Assuming that the probability of emission of a photoelectron is proportional to the square of the amplitude of the incident light, one can use classical electromagnetic wave theory to calculate the correlation between the fluctuations in the current from the two cathodes. On this assumption it can be shown that, with the two cathodes superimposed, the correlation $S(0)$ is given by :

$$S(0) = A.T.b_v.\mathrm{f}\left(\frac{a_1\theta_1\pi}{\lambda_0}\right).\mathrm{f}\left(\frac{a_2\theta_2\pi}{\lambda_0}\right)\int \alpha^2(\nu).n_0^2(\nu).\mathrm{d}\nu \quad (1)$$

It can also be shown that the associated root-mean-square fluctuations N are given by :

$$N = A.T.\frac{2m}{m-1}.b_v\,(b_vT)^{-\frac{1}{2}}\int \alpha(\nu).n_0(\nu).\mathrm{d}\nu \quad (2)$$

where A is a constant of proportionality depending on the amplifier gain, etc. ; T is the time of observation ; $\alpha(\nu)$ is the quantum efficiency of the photocathodes at a frequency ν ; $n_0(\nu)$ is the number of quanta incident on a photocathode per second, per cycle bandwidth ; b_v is the bandwidth of the amplifiers ; $m/(m-1)$ is the familiar excess noise introduced by secondary multiplication ; a_1, a_2 are the horizontal and vertical dimensions of the photocathode apertures ; θ_1, θ_2 are the angular dimensions of the source as viewed from the photocathodes ; and λ_0 is the mean wave-length of the light. The integrals are taken over the complete optical spectrum and the phototubes are assumed to be identical. The factor $\mathrm{f}\left(\frac{a\theta\pi}{\lambda_0}\right)$ is determined by the dimensionless parameter η defined by

$$\eta = a\theta/\lambda_0 \quad (3)$$

which is a measure of the degree to which the light is coherent over a photocathode. When $\eta \ll 1$, as for a point source, $\mathrm{f}(\eta)$ is effectively unity ; however, in the laboratory experiment it proved convenient to make η_1, η_2 of the order of unity in order to increase the light incident on the cathodes and thereby improve the ratio of signal to noise. The corresponding values of $\mathrm{f}(\eta_1)$, $\mathrm{f}(\eta_2)$ were 0·62 and 0·69 respectively.

When the centres of the cathodes, as viewed from the source, are displaced horizontally by a distance d, the theoretical value of the correlation decreases in a manner dependent upon the dimensionless parameters, η_1 and d/a_1. In the simple case where $\eta_1 \ll 1$, which would apply to an experiment on a visual star, it can be shown that $S(d)$, the correlation as a function of d, is proportional to the square of the Fourier transform of the intensity distribution across the equivalent line source. However, when $\eta \gg 1$, as in the present experiment, the correlation is determined effectively by the apparent overlap of the cathodes and does not depend critically on the actual width of the source. For this reason no attempt was made in the present experiment to measure the apparent angular size of the source.

The initial observations were taken with the photocathodes effectively superimposed ($d=0$) and with varying intensities of illumination. In all cases a positive correlation was observed which completely disappeared, as expected, when the separation of the photocathodes was large. In these first experiments the quantum efficiency of the photocathodes was too low to give a satisfactory ratio of signal to noise. However, when an improved type of photomultiplier became available with an appreciably higher quantum efficiency, it was possible to make a quantitative test of the theory.

A set of four runs, each of 90 min. duration, was made with the cathodes superimposed ($d=0$), the counter readings being recorded at 5-min. intervals. From these readings an estimate was made of N_e, the root mean square deviation in the final reading $S(0)$ of the counter, and the observed values of $S_e(0)/N_e$ are shown in column 2 of Table 1. The results are given as a ratio in order to eliminate the factor A in equations (1) and (2), which is affected by changes in the gain of the equipment. For each run the factor

$$\frac{m-1}{m}\int \alpha^2(\nu)n_0^2(\nu)\mathrm{d}\nu \Big/ \int \alpha(\nu)n_0(\nu)\mathrm{d}\nu$$

was determined from measurements of the spectrum of the incident light and of the d.c. current, gain and output noise of the photomultipliers ; the corresponding theoretical values of $S(0)/N$ are shown in the second column of Table 1. In a typical case, the photomultiplier gain was 3×10^5, the output current was 140 μamp., the quantum efficiency $\alpha(\nu_0)$ was of the order of 15 per cent and $n_0(\nu_0)$ was of the order of 3×10^{-3}. After each run a comparison run was taken with the centres of the photocathodes, as viewed from the source, separated by twice their width ($d=2a$), in which position the theoretical

Table 1. COMPARISON BETWEEN THE THEORETICAL AND EXPERIMENTAL VALUES OF THE CORRELATION

	Cathodes superimposed ($d = 0$)		Cathodes separated ($d = 2a = 1{\cdot}8$ cm.)	
	Experimental ratio of correlation to r.m.s. deviation $S_e(0)/N_e$	Theoretical ratio of correlation to r.m.s. deviation $S(0)/N$	Experimental ratio of correlation to r.m.s. deviation $S_e(d)/N_e$	Theoretical ratio of correlation to r.m.s. deviation $S(d)/N$
1	+ 7·4	+ 8·4	− 0·4	≃ 0
2	+ 6·6	+ 8·0	+ 0·5	≃ 0
3	+ 7·6	+ 8·4	+ 1·7	≃ 0
4	+ 4·2	+ 5·2	− 0·8	≃ 0

correlation is virtually zero. The ratio of $S_e(d)$, the counter reading after 90 minutes, to N_e, the root mean square deviation, is shown in the third column of Table 1.

The results shown in Table 1 confirm that correlation is observed when the cathodes are superimposed but not when they are widely separated. However, it may be noted that the correlations observed with $d = 0$ are consistently lower than those predicted theoretically. The discrepancy may not be significant but, if it is real, it was possibly caused by defects in the optical system. In particular, the image of the arc showed striations due to imperfections in the glass bulb of the lamp; this implies that unwanted differential phase-shifts were being introduced which would tend to reduce the observed correlation.

This experiment shows beyond question that the photons in two coherent beams of light are correlated, and that this correlation is preserved in the process of photoelectric emission. Furthermore, the quantitative results are in fair agreement with those predicted by classical electromagnetic wave theory and the correspondence principle. It follows that the fundamental principle of the interferometer represented in Fig. 1*b* is sound, and it is proposed to examine in further detail its application to visual astronomy. The basic mathematical theory together with a description of the electronic apparatus used in the laboratory experiment will be given later.

We thank the Director of Jodrell Bank for making available the necessary facilities, the Superintendent of the Services Electronics Research Laboratory for the loan of equipment, and Mr. J. Rodda, of the Ediswan Co., for the use of two experimental phototubes. One of us wishes to thank the Admiralty for permission to submit this communication for publication.

[Oct. 5

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OBSERVATIONS OF WHISTLING ATMOSPHERICS AT GEOMAGNETICALLY CONJUGATE POINTS

WE have observed whistlers, most recently described comprehensively by L. R. O. Storey[1], to occur simultaneously at 55·1° and 50·2° N. geomagnetic latitude on the east coast of North America, and have found the individual whistlers to have essentially identical characteristics at the two stations for the particular period of activity studied. All individual whistlers observed at either station were accompanied by a simultaneous occurrence at the other station, but for each occurrence the stronger whistler did not always occur at the same station. Apart from intensity variations, other characteristics were essentially uniform throughout the observing period.

Tape recordings of whistlers simultaneously observed at the two locations, Hanover, N.H., and Washington, D.C., were analysed on a comb-filter type of sound spectrograph, and Figs. 1 and 2 show typical examples taken from more than a hundred occurrences on March 1, 1955, between 09.45 and 10.15, 75° W. standard time. The most probable source of storms for producing these whistlers appears from weather data to have been in the State of New York at a geomagnetic latitude of about 54° N.

The dotted curves plotted on the spectrograms are the function $f = (D/t)^2$, where t is measured from the initiating atmospheric. This formula, which is Storey's form of the frequency-dependence given by Eckersley[2], is seen to fit the data rather well for $D = 200$. The dispersion D as given by Storey's

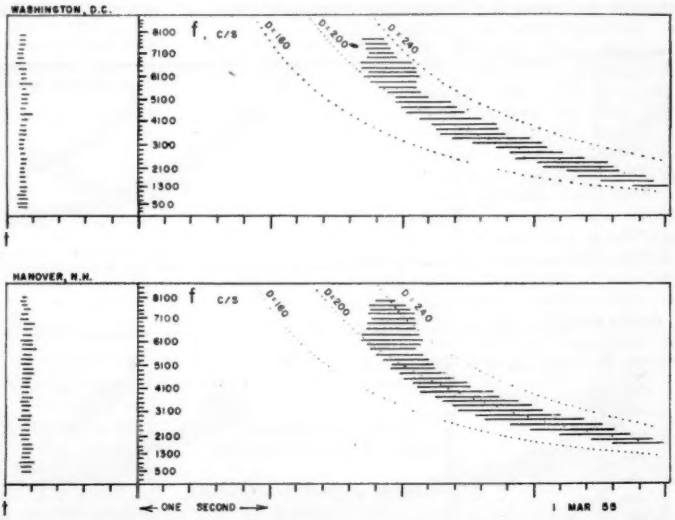

Fig. 1. An atmospheric followed about 2·5 sec. later by the commencement of a whistler. The atmospheric was observed to occur simultaneously at both stations within the limits of the timing method used (about ± 0·1 sec.) and, there being no others of comparable amplitude within a few seconds, is reasonably assumed to be the same atmospheric on both records

equation 15 is proportional to the expression $\sqrt{N}/B\,ds$ integrated over the propagation path, where N is the electron density, B the static magnetic field, and ds the differential path-length. Considering the effect of path-length only, and considering the path to be along the flux of the simple geomagnetic field, a difference of 35·6 per cent in D between the two points of observation is computed. (Inclusion of the field in the integral leads to $\int (1 + 3\cos^2\theta)^{1/4} \sin^3\theta d\theta$, which we have not succeeded in integrating directly.) This difference does not seem to appear in the observations, and we conclude tentatively that the observed dispersion does not necessarily depend upon the latitude of the observer but rather upon the latitude of the storm source. If this conclusion is correct, and if the ability to hear a whistler depends upon the proximity of the observer to the location, or the geomagnetically conjugate location, of the atmospheric generating it, then one would expect the distribution of the dispersions of all whistlers heard at a station to depend upon the latitude of that station. On the other hand, we have never observed whistlers to result from lightning which could be seen from the point of whistler observation.

(*Note added in proof, November* 25. A. G. Jean, of the National Bureau of Standards, Boulder, Colorado, has reported to us in recent conversations that he has on one occasion heard whistlers apparently associated with visible lightning flashes. It should also be recalled that E. T. Burton and E. M. Boardman reported in 1933 a direct correspondence with flashes of undetermined kind seen near the apparent end of an auroral arc[3].)

We have noted that atmospherics which produce whistlers usually have a characteristic sound. Continuing the onomatopœic vocabulary started by E. T. Burton[4], we have called these 'bonks'. There are many gradations between a 'whistler' (a term first used by Eckersley[5]) and a 'swish', a term first used by Burton. The former is a descending tone, whereas the latter is a descending frequency band of noise. We submit that the accompanying records are of bonks followed by swishlers.

We wish to acknowledge the assistance of our colleagues at our respective institutions: H. W. Curtis, W. C. Johnson and B. Pratt at Dartmouth College; and J. E. Raudenbush and W. E. Garner at the Naval Research Laboratory.

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[2] Eckersley, T. L., *Nature*, **135**, 104 (1935).
[3] Burton, E. T., and Boardman, E. M., *Proc. Inst. Rad. Eng., New York*, **21**, 1490 (1933).
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[5] Eckersley, T. L., *Nature*, **122**, 768 (1928).

Observations which we have conducted near geomagnetically conjugate points at about 50° geomagnetic latitude in the Aleutian Islands and in New Zealand appear to confirm L. R. O. Storey's remarkable theory that the long, dispersive paths needed by T. L. Eckersley to explain the generation of 'whistlers' and 'swishes' from atmospherics are along the geomagnetic flux lines between the northern and southern hemispheres[1,2]. Simultaneous recording on magnetic tape on a schedule of 4 min./3 hr. was begun on August 23, 1955 Z (Z = zero meridian reference), at Unalaska and at sites near Wellington and Dunedin, N.Z. Unalaska and Wellington are within 250 miles of geomagnetically conjugate points, and Unalaska and Dunedin are within 75 miles of such points. Activity at all stations was very low until August 28 at 11.40 Z, when weak whistler activity commenced at all stations. The strength of the activity had increased somewhat by 14.40 Z, and further at 17.40 Z. During the latter schedule, four good examples of whistler trains[3] were observed at both the northern and southern stations. The low rate of occurrence, and the timing accuracy used, were such that there can be little doubt of the correspondence of the phenomena at the northern and southern stations. There were no other occurrences of comparable nature and magnitude at any of the stations during the schedule. Further activity occurred on the 14.40 Z and 17.40 Z schedules on September 1. On that day the occurrences were strong but less frequent, and the background noise was particularly low.

In the accompanying spectrograms it is seen that the essential details of Storey's theory are amply borne out. The spectrograms are tracings of records

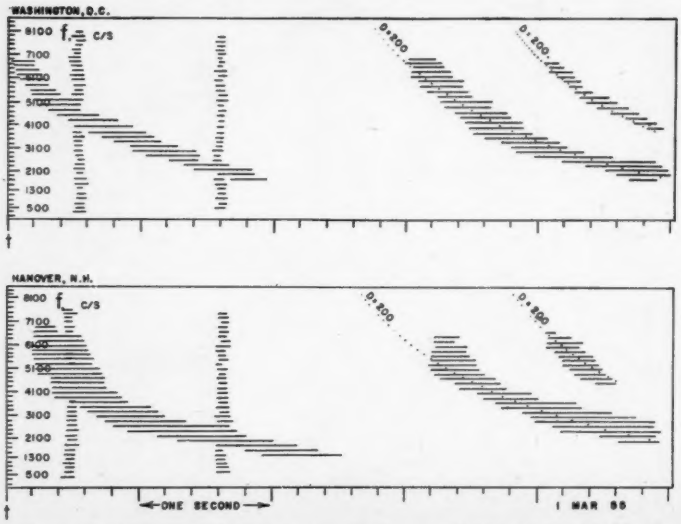

Fig. 2. A whistler punctuated by two atmospherics, each of which is followed in about 2·5 sec. by the commencement of a whistler

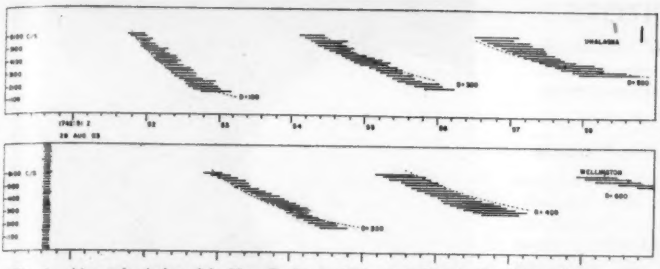

Fig. 1. Atmospheric heard in New Zealand which, according to the Storey theory, produced a whistler in Alaska after being smeared out by propagation over the long dispersive path along the geomagnetic flux lines connecting the two locations. The whistler then returned to New Zealand, further dispersed by another transit of the path, returned to Alaska still further dispersed, etc. The attenuation produced by a round trip is sometimes as low as 2 db.

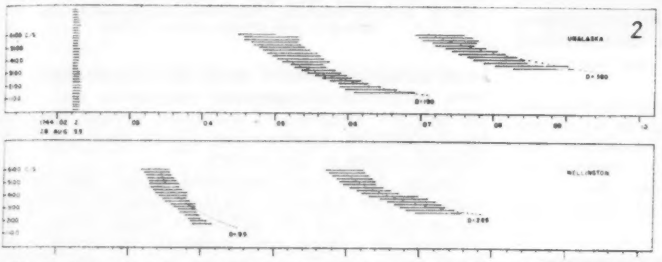

Fig. 2. Atmospheric heard in the Aleutians which produced a whistler in New Zealand, returned to Alaska, etc.

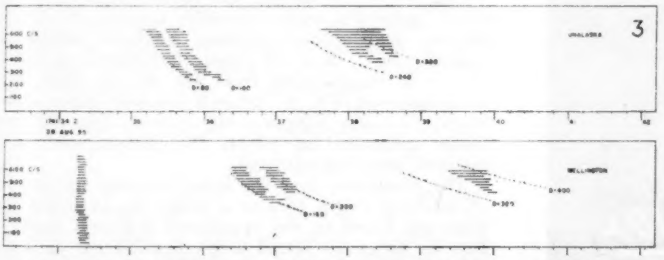

Fig. 3. A whistler pair produced by a single atmospheric. This type, reported by Storey, apparently results from independent propagation over two paths

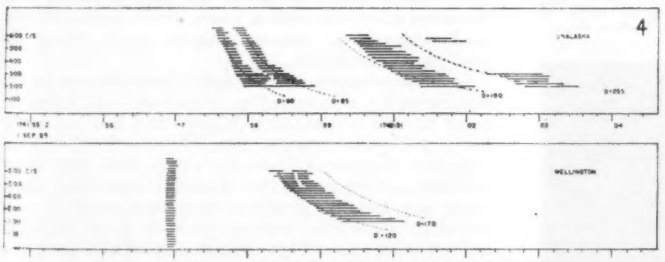

Fig. 4. Another whistler pair produced by a single atmospheric

made with a comb-filter with a stylus for each filter writing on electrically sensitive paper. The values of D shown are from the equation $t = D/\sqrt{f}$, which is Storey's form of the frequency dependence given by Eckersley. The origin of t is taken at the leading edge of the generating spheric in each example.

The estimated timing accuracy was $\pm$ 0·3s. at each station for the August 28 schedule at 17.40 *Z* and $\pm$ 0·5s. at each station for the September 1 schedule at 17.40 *Z*. The times shown on the spectrograms are those determined for the Alaska records. The New Zealand records have been registered as if the performance were according to Storey's theory. This required adjusting the New Zealand times by adding the following amounts: for August 28, 1741.34, 0·2s.; for 1742.51, 0·4s.; and for 1744.02, 0·4s. For September 1, 1741.55, 0·1s. was added.

The Dunedin records have been found to be closely identical with the Wellington records. This is as we would expect from experience in North America, in which simultaneous observations at Washington, D.C., and Hanover, N.H., were compared[3].

The consistence of these results with Storey's theory permits the planning of a synoptic programme of observation during the coming International Geophysical Year with much greater confidence and insight. We are grateful to the U.S. National Academy of Sciences for sponsoring this international scientific experiment and for assisting us with funds obtained from the U.S. National Science Foundation for costs other than salaries. We hope that the successful outcome of the experiment on an informal basis is but a precursor of many others planned for the International Geophysical Year.

We are especially indebted to H. W. Curtis, of Dartmouth College, who established the station and made the observations at Unalaska, to the U.S. Navy's Bureau of Ships for making his time available, to the U.S. Military Air Transport System for his return transportation, and to the Alaska Communication System of the U.S. Army Signal Corps for assistance and hospitality to him at Unalaska. We are also very much indebted to L. H. Martin, of the New Zealand Broadcasting Service, who established the station and made the observations near Dunedin. Lastly, we thank H. E. Dinger, of the U.S. Naval Research Laboratory, for preparation of the original spectrograms, and W. C. Johnson, of Dartmouth College, for their reproduction.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Cosmic Spherules in Deep-Sea Sediments

In 1876, Sir John Murray[1] published observations on magnetic spherules extracted from deep-sea sediments collected by the *Challenger* Expedition. Together with Renard[2], he later described them more fully and gave strong reasons for assuming them to have a cosmic origin. Very few observations have since then been published on these spherules. The two most recent publications are by Bruun, Langer and Pauly[3] describing magnetic particles collected from the sediment surface by the *Galathea* Expedition, and by Laevastu and Mellis[4], working in Göteborg, who extracted, counted and measured black spherules from one ordinary long core from the Swedish Deep-Sea Expedition.

During the Swedish Deep-Sea Expedition with the *Albatross* a number of thick cores, up to 5½ metres long, were collected from different localities and depths in order to obtain more exact observations on the supply to the Earth of cosmic particles during the past few million years[5]. Some of these cores have, in the Institute of Oceanography in Göteborg, been subjected to magnetic extraction and have yielded, per kilogram of sediment, several hundred black spherules, greater than 35μ in diameter, from different layers in the cores[6].

Fig. 1. Spherule from *Albatross* Core 71 (lat. 07° 38′ S., long. 152° 53′ W., depth 4,990 m.). Sample 93, 160 cm. below the sediment surface. Magnetite, grey; metallic nucleus, white

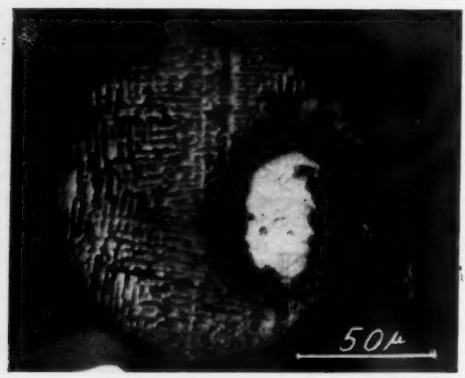

Fig. 2. Spherule from the same sample as Fig. 1. Dendritic magnetite, grey, probably in silicate, and metallic nucleus, white. The black area around the nucleus is void

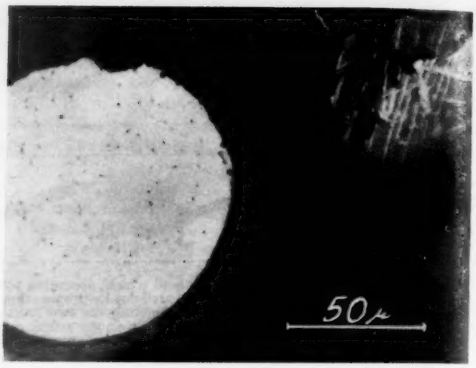

Fig. 3. Artificial spherules. Magnetite, grey; hæmatite lamellæ, light grey; and metallic nucleus, white

Doubts have been expressed about the cosmic origin of these spherules. In the course of our experiments, several of the spherules found have been mounted in plastic and polished, in many cases displaying a metallic nucleus inside a superficial layer of magnetite (Fig. 1), presumably due to oxidation during the flight through the atmosphere. In most of the spherules with a metallic nucleus the metal reduces acid copper sulphate solution, indicating metallic iron. In a few cases a structure, probably due to a consolidation from the molten state, has been observed (Fig. 2). Since a volcanic origin is not likely, this also supports the cosmic origin of the black spherules on which the investigation has hitherto been concentrated.

The possibility that the spherules may in part be of artificial origin cannot *a priori* be excluded for spherules found in the uppermost sediment surface. But for spherules found a few centimetres or more below the surface layer in deep-sea sediments, this origin can be ruled out. In fact, we have found spherules in sediment layers the age of which is of the order of several million years, proving that already in Tertiary time cosmic spherules were being deposited on the Earth.

In interpreting magnetic spherules collected on the continents by, among others, Buddhue and Thomsen[7], great caution is necessary. Hoppe and Zimmermann[8] have published results from attempts to collect magnetic fragments from the air in Jena and other localities, which prove that magnetic spherules found there are largely products from industries in the vicinity. This they assume to have been the case, at least with some of the magnetic spherules described by Thomsen. Similar experiments made in Göteborg confirm this view. We have also found that black magnetic spherules, obtained by means of an oxygen flame from an iron wire, consist of magnetite with or without a metallic nucleus, and that they are very similar to the true cosmic spherules (Fig. 3).

Prof. H. Pettersson has proposed that a collection of meteoritic dust and fragments should be undertaken during the International Geophysical Year, preferably on islands in the Pacific Ocean. Prelim-

inary experiments for this purpose have already been started near Bornö Station in the Gullmar Fjord.

A detailed report on our finds is in preparation.

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Enhanced Initiating Effect of Multiple Shock Intersections

PREVIOUS work has shown that underwater shock-wave initiation of cast pentolite can be photographed advantageously by a simple argon flash-lamp method in which a common mechanical-shutter camera is used[1]. Very minute scintillations were usually evident on the detonating pentolite charges, presumably because of the presence of minute air pockets between the particles situated near the surface of the charges. These air pockets probably provided a multitude of initiation centres. Bowden and co-workers have obtained photographic evidence that bubbles in nitroglycerin and air pockets in solid explosives enhance initiation and that initiation occurs at these bubbles or gas pockets[2].

When these results were discussed with Dr. F. P. Bowden, of Cambridge, he suggested to us that initiation of a receptor also might be enhanced by multiple or reinforced shock waves acting simultaneously on the explosive receptor. The arrangement to be described here was used to obtain photographic evidence of such an effect. Commercial nitroglycerin (a mixture of glycerin trinitrate and glycol dinitrate) was selected for the investigation because of uniformity in properties and the normal absence of air bubbles.

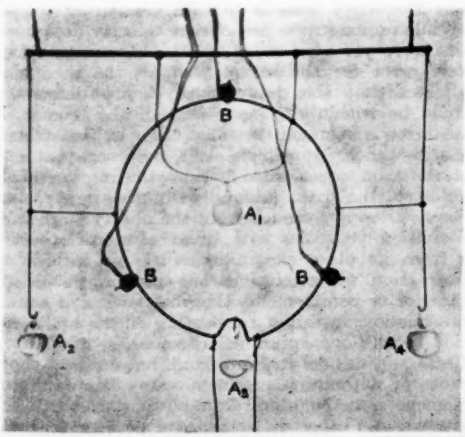

Fig. 1

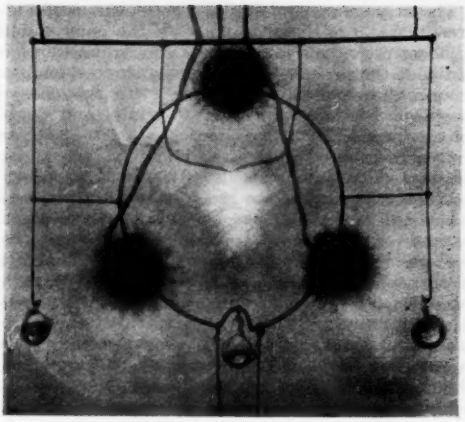

Fig. 2

The arrangement shown in Fig. 1 consisted of four nitroglycerin receptors (A) spaced uniformly about three evenly separated blasting caps (B). About 1·5–2·0 gm. of nitroglycerin was contained in each thin glass bulb, which weighed about 0·2 gm. Two individual receptors, A_2, A_4, were exposed simultaneously to a single shock; one, A_3, to a double intersecting shock; and a third, A_1, to a triple intersecting shock from the three blasting caps fired simultaneously. The location of the individual receptors with respect to the caps determined whether the exposure was to a single, double-intersecting, or triple-intersecting shock. Simultaneous firing of caps in series connexion was obtained by using a special arc-fired cap rather than the usual bridge-wire type. The caps were mounted at equal distances from each other on the central wire ring. The base charge was 5 grains of PETN.

Fig. 2 is an argon flash-lamp picture[3] (back lighted; about 0·5 μsec. exposure; 1/200 sec. shutter) that shows the underwater shock waves when in contact with all receptors, the centres of which were essentially 2½ in. from the nearest caps. Only the central receptor that was exposed to a triple shock intersection was initiated. None of the other receptors was initiated.

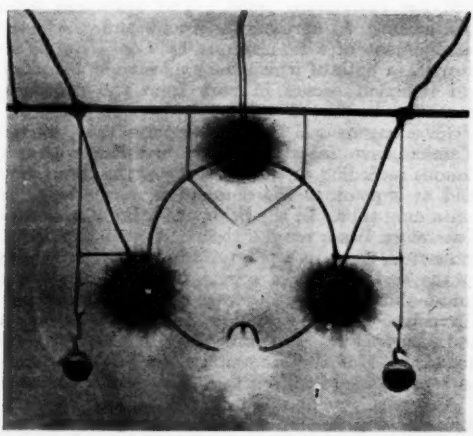

Fig. 3

The arrangement of Fig. 3 was like that of Fig. 2 except that the distance between the caps and the adjacent nitroglycerin receptors was reduced by $\frac{1}{4}$ in., and that the picture was taken sooner to show again the simultaneous shock influence. In this case the receptors that were exposed to triple- and double-intersecting shocks were initiated. The receptors that were exposed to the singly arriving shocks from the caps did not explode.

When explosion of the receptor is accompanied by a brilliant flash, it is not possible to determine the instant of initiation, because the brilliant flash obscures the state of gas expansion and the location of the shock wave about the receptor. With less luminous receptors the simple flash method provides much information about underwater shock-wave initiation. When nitroglycerin is used, some detailed information is lost, and accordingly future work is planned with a Kerr-cell, rapid-shutter camera. It is clear, however, that weak shock waves which are unable singly to initiate explosion can do so when they meet and reinforce one another.

I greatly appreciate the suggestions kindly given by Dr. F. P. Bowden.

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Microwave Observation of Detonation

The usual methods for the measurement of the detonation velocity of explosives either do not permit the free selection of conditions of confinement or do not permit the observation of velocity with a high degree of continuity[1].

We have recently developed a technique for measuring the velocity of detonation of various high explosives under contained conditions by means of the reflexion of microwaves from a region travelling with the detonation front. The technique differs substantially from that of Koch[2] and the recent development of his technique by Cook, Doran and Morris[3], in both of which the explosive is unconfined and reflexion occurs in part from the detonation front and in part from the detonation products.

Our experimental method employs the principles of microwave interferometry[4], together with continuous recording of the intensity of the interference field at a point as the detonation moves along the containing tube. In the primitive form of apparatus, a standard brass mould stemmed with explosive is connected, through a polytetrafluorethylene window, to the end section of a rectangular *Q*-band waveguide, thus forming the variable arm of the interferometer. The wave is guided over the whole forward and return path. The explosive is initiated from the distant end of the stemming, and the interference pattern is recorded together with time markers.

A typical oscillograph record of the pattern is shown in Fig. 1. This is for a stable detonation in a 0·6 in. external diameter brass mould of a 2 in. × 0·152 in. diameter stemming of 1·39 gm.cm.$^{-3}$ tetryl. The trace from *A* to *B* corresponds to the progress of the detonation in the explosive stemming; *B* to *C* represents the bursting of the polytetrafluorethylene window and the reforming of an adequate reflexion front in the rectangular wave-guide. The remaining portion of the trace is due to reflexion occurring in the rectangular wave-guide from the shock front, or perhaps from the detonation products travelling with a considerably reduced velocity. The time base shows microsecond marker intervals. For this particular case the detonation velocity derived from the oscillogram is about 6,600 m.sec.$^{-1}$ and the velocity of the front in the wave-guide after detonation is about 3,600 m.sec.$^{-1}$.

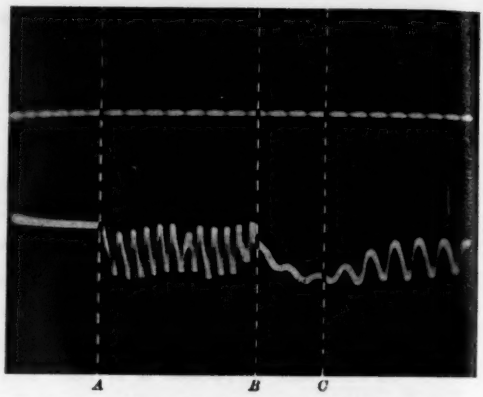

Fig. 1. An oscillogram showing complete detonation in tetryl, the penetration of a polytetrafluorethylene window and the subsequent event in the rectangular wave-guide

To derive the velocities from the oscillogram, all that is required is a knowledge of the guide wavelength appropriate to the region. For the case of the detonation velocity determination, in addition to the microwave frequency, the dielectric properties (permittivity and loss factor) of the explosive must be known. Measurements of these properties have been made over a range of densities by the usual cavity techniques for a number of high explosives. In all cases the loss factors are sufficiently low to cause no appreciable attenuation. In the example given above the relative permittivity was 2·73, and the microwave frequency was 34·50 kMc.

While no extensive detonation velocity determinations have yet been made by us, an estimate of the likely error for the initial form of the equipment indicates that the detonation velocity determined should lie within $\pm$ 1$\frac{1}{2}$ per cent of the true value. This error is of much the same order as the errors in other methods. It will be clear, however, that since the reflexion arises entirely from the interior of the explosive, the main advantage of the new method does not derive so much from the ability to measure detonation velocities with great absolute accuracy, as from its other possibilities. These include the observation of relative variations due to density, diameter or confinement, the observation of contact transmission, instability and other effects under confined conditions, and the avoidance of external effects during detonation from luminosity, shock-waves or detonation products. Any degree of confinement may be used, from very thin metal foils upward, and other materials may be used with thin internal metal deposits.

In the oscillograms obtained it is easy to discriminate four phase points in each period, and thus a definite distance from some arbitrary fixed point in the explosive is located at about every millimetre in the example discussed. This distance defines the degree of continuity in the present observations, but developments in the recording system are immediately possible and a finer distance resolution will result.

Full details of the method and associated dielectric measurements will be given elsewhere. This communication is published by permission of the Chief Scientist, Australian Commonwealth Department of Supply.

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Department of Supply,
Australia. July 25.

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Search for Point Source of Cosmic Rays

IN order to search for possible point sources of cosmic rays, an alt-azimuth Geiger–Müller counter telescope of narrow angular resolution (5° × 5°) was made, and kept nearly horizontal (zenith distance $Z = 80°$) so that the effective cosmic-ray particles were free from complicated geomagnetic deflexion. After scanning over the celestial sphere, especially large intensities were observed at two positions as noticed in our earlier paper[1].

In order to confirm one of them (declination $\delta = 0°$, right ascension $\alpha = 5$h. 30m., before entering into the geomagnetic field), observations of a small part of the celestial sphere including the position have been repeated since April 1954, with the telescope (No. 1) described above. Meanwhile, another telescope (No. 2) with higher accuracy was built, which can observe five adjacent declination bands at once with narrow angular resolution (4° × 5°). Observations with two telescopes have been repeated since July 13, 1955. Observations were carried out at the zenith distance $Z = 80°$, twice a day at two azimuths, $A = 85°$ and $A = 255°$, respectively. The following results were obtained from the observations up to August 18, 1955.

The relative intensities in the part of the celestial sphere ($\delta = 0°$, 4h. 10m. $< \alpha <$ 6h. 30m.) are shown in the central part of Fig. 1, where the eight points were observed with equal statistical accuracy. The count at the position marked by the previous scanning ($\alpha = 5$h. 30m.) is $N = 1{,}264$, while the average of the other seven positions is $N_0 = 1{,}091{\cdot}6$. Therefore,

$$N - N_0 = +0{\cdot}157\,N_0 = +5{\cdot}2\sqrt{N_0}$$

or the significance-level is about 10^{-6}. Thus, this position was confirmed to be a point source of cosmic rays. This is the first example of a particular point source, though the existence of point sources was presumed through the statistical arguments in our previous paper[1].

The results over a little larger part of the celestial sphere are shown in Fig. 1, where the statistical accuracies corresponding to the various points are not constant. Therefore, the ordinate is not the relative count $(N - N_0)/N_0$, but the count divided by the standard deviation corresponding to the observation of each point, $(N - N_0)/\sqrt{N_0}$, where N_0 is not constant. From the observations up to August 18, no point source except that described above was found in the part of the celestial sphere shown in the figure, provided that fluctuations less than 2·5 standard deviations are regarded as insignificant.

The increase at the point source was 20 ± 8 per cent by telescope No. 2, which includes no effect of side showers. It was 19 ± 4 per cent by telescope No. 1, after correction for the side showers. Thus, the intensity of cosmic rays from the point source is 20 ± 4 per cent of the background cosmic rays in the solid angle 5° × 5°, so the point source con-

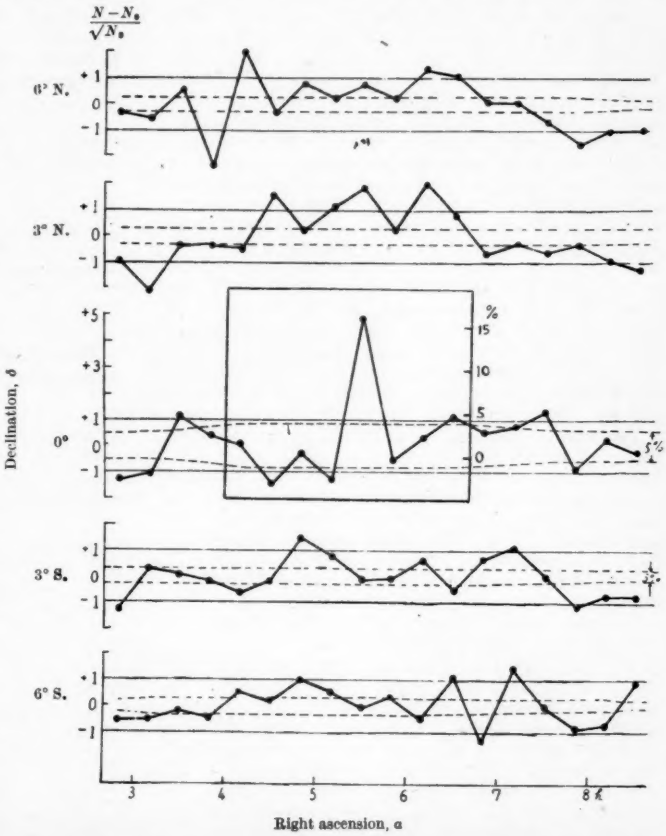

Fig. 1. A part of the celestial sphere observed with alt-azimuth cosmic-ray telescopes. Ordinates: $(N-N_0)/\sqrt{N_0}$. In the central part of the figure, where observations were made with high and uniform accuracy, the ordinate is scaled also by $(N-N_0)/N_0$. Horizontal lines: $N-N_0 = \pm\sqrt{N_0}$. Dotted curves: $(N-N_0)/N_0 = \pm 2{\cdot}5$ per cent

tributes 0·016 per cent of total cosmic rays in the same energy region. The angular width of the point source was estimated by various methods to be not more than 5°. Increase of cosmic rays at the position was observed at both azimuths. Positions observed at the two azimuths were identified through the correction for the geomagnetic deflexion, which depends on the charge and momentum of effective primary particles. They were presumed statistically to be positive and 2 Størmers ($P \doteqdot 240$ GeV./c.) respectively by the previous scanning, and were shown to be correct through the observation of this particular point source.

We thank Prof. Y. Hagihara and Prof. T. Hatanaka for their interest and discussions.

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The Near Ultra-Violet Bands of *para*-Dichlorobenzene

The bands in the near ultra-violet of *p*-dichlorobenzene were first studied in absorption by Wollman and reported by H. Sponer[1], who gave a general analysis and description of the bands. Recently, T. Anno and T. Matubara[2] have published a detailed analysis of these absorption bands obtained at different temperatures. Work on these bands, in absorption as well as in emission, has been in progress in this laboratory for some time past. Comparison of our results with those of earlier workers is thought worthy of advance publication, since the spectrum has also been obtained in emission and there are a few interesting points of difference in analysis.

The position of the zero band as measured by us is 35,755 cm.$^{-1}$ in absorption and 35,752 cm.$^{-1}$ in emission. The divergence is within experimental error. The value is again in agreement with that in absorption reported by Anno and Matubara, namely, 35,750 cm.$^{-1}$, but differs from that given by Sponer, namely, 35,743 cm.$^{-1}$.

The main progression, which consists of doublet bands, involves the upper-state frequencies near 1,061 and 1,051. Anno and Matubara correlate these frequencies with the ground-state frequencies 1,164 and 1,102 respectively, observed in absorption and Raman effect. But in the emission spectrum obtained by us, there is a broad band at 34,672 cm.$^{-1}$, which perhaps represents two unresolved bands involving the ground-state frequencies 1,084 and 1,071. The ground-state frequencies 1,164 and 1,102 do not seem to occur in the emission spectrum. Further, from the polarization measurements of the Raman lines, Saxena and Narain[3] suggest that perhaps 1,084 and 1,071 form a Fermi doublet. Thus the data of the emission spectrum and the intensity and polarization of the Raman lines appear to favour the correlation of the upper-state frequencies 1,061 and 1,051 to the ground-state frequencies 1,084 and 1,071 rather than to 1,164 and 1,102 respectively.

The ground-state frequency 248 observed by us and also by Anno and Matubara does not seem to have a corresponding Raman line, unless it is a very faint line at 232 cm.$^{-1}$ reported by Kohlrausch and Paulsen[4] (and referred to by Sponer and Nordheim[5]). In emission, there is a band of medium intensity on the longer wave-length side of the zero band at a separation of 251 cm.$^{-1}$. This band probably corresponds to the ground-state frequency 248 observed in absorption.

The totally symmetric ground-state frequency 331 is correlated with 244 in the excited state by Anno and Matubara. But the intensity of the band involving the frequency 244 is low, and although this is not, by itself, an argument against its being totally symmetric, we prefer to regard it as a satellite of the band involving the upper-state frequency 329. This assignment has also been suggested as an alternative one by Anno and Matubara.

The prominent difference-frequencies of about 25 and 85 are observed by all workers. Of the other difference-frequencies 9 and 16 reported by Anno and Matubara, only the first occurs in association with weak bands on our plates, while there is no trace of the bands involving the difference-frequency 16. This is no doubt due to the fact that we restricted our studies to room temperature, about 30° C., where this difference-frequency is either absent or very weak[2].

The occurrence of the ground-state frequencies 302 and 486 is regarded as rather uncertain by us, as the bands involving these frequencies can have alternative assignments.

A detailed treatment of the bands obtained in absorption and emission is to be published elsewhere.

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Correlation of Nuclear Quadrupole Interaction Frequencies with Polarographic Half-Wave Potentials

When the nuclear quadrupole interaction frequencies of some aryl iodo-compounds are plotted against the corresponding half-wave potentials of these compounds at *p*H 7 (Fig. 1) a general linear

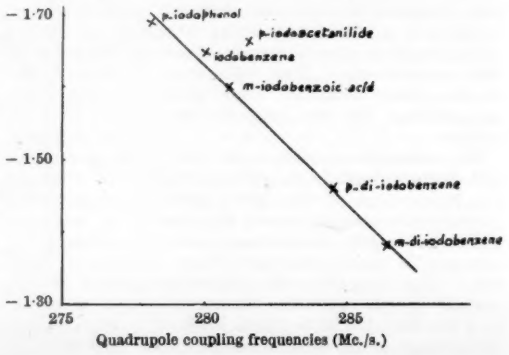

Fig. 1

trend is obvious; but the departure from linearity in the case of the iodoanilines is more serious (points not shown on graph). The data are taken from results obtained by E. Gergely and me[1], those of Colichman and Liu[2], and the quadrupole interaction measurements of Hatton and Rollin[3], and of Barnes, Miller and Wooten[4]. Colichman and Liu have attempted a correlation of their polarographic data on iodo-compounds with Hammett's σ-function. Hatton and Rollin have attempted a similar correlation of their quadrupole data and Hammett's σ for bromine and iodine compounds. However, Colichman and Liu found the same misbehaviour of *p*-iodoaniline as we did, and it is equally obvious that the *m*- and *p*-di-iodobenzenes (as evidenced from our own results which are not substantially different from theirs) would not fit their straight line. On the other hand, Hatton and Rollin found, in their quadrupole $-\sigma$ relationship, that these three substances fell very well into line. It is clear that the triangular agreement we expect to find from the results of these four groups of workers is very imperfect, and the interrelation of the three phenomena greatly in need of clarification.

Quadrupole resonances are invariably measured with the substances studied in the crystalline form, whereas polarographic studies and reaction kinetics are undertaken in solution. This distinction is only of importance when crystal forces can seriously modify the nature of the bonding of the relevant atom. At least we know the nucleus is moving in a crystalline, electric field, different sometimes from that where the molecule is gaseous or in the dissolved, liquid state. Moreover, change of vibrational level can modify the quadrupole frequency[5].

Hammett's[6] σ, defined as $-A/2{\cdot}303\,R$, is said to measure the tendency of the substituent to displace electrons. A has the dimensions of an energy term, and might be expected to represent a variation in some energy of activation necessary to overcome a potential barrier[7]. The same is true of the half-wave potential, although the idea behind this may be more elementary, involving the conception of an electron adding on to a molecule as a preliminary step in cathodic reduction. We would say that the greater the electron density at the region where the electron is expected to add on, the greater would be the half-wave potential.

Variations in the quadrupole frequency (or the quadrupole coupling constant, 20/3 times the first frequency in the case of iodine[7]) are due to changes in the asymmetry of the field modifying the nuclear motion. The half-wave potential may be regarded as some measure of the field in a region remote from the nucleus, but its variations may be of the same order as the variations in quadrupole frequency. I hope to accumulate more observations to test the relationships described in this communication, which, at present, must be regarded as forming the basis of only tentative hypotheses.

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Crystal Structure of Glycyl-L-Alanine Hydrochloride

In the course of a programme of research into the crystal structures of simple synthetic peptides undertaken in the laboratories of the Wool Industries Research Association, glycyl-L-alanine has been synthesized and the structure of its hydrochloride elucidated using two-dimensional methods. As indicated in an earlier communication[1], the hydrochloride and hydrobromide of glycyl-L-alanine are isomorphous, with the following cell constants:

	Hydrochloride	Hydrobromide
a (A.)	10·62	10·69
b (A.)	5·98	6·13
c (A.)	7·57	7·63
β	109° 2′	108° 36′

and from the systematic absences observed the space group may be inferred to be P_{2_1}. The density of the hydrochloride by flotation is 1·465 gm. cm.$^{-3}$, which necessitates the presence of two molecules of peptide and two molecules of water of crystallization in the unit cell. The existence of the latter was confirmed analytically.

The general features of the structure in projection along the *b*-axis had already been determined for the hydrobromide[1], and the atomic co-ordinates were refined by successive Fourier syntheses using the hydrochloride intensity data (reliability index 0·18).

From the various atomic arrangements possible along the *c*-axis, it was not found possible to select the correct one on the basis of a limited number of structure-factor calculations. However, the final choice was readily made by consideration of the double Fourier projection as employed by Bijvoet *et al.*[2], and Smits and Wiebenga[3]. The *hk*0 intensities of the hydrobromide and hydrochloride were employed to derive the phase angles with a sign ambiguity, and the structure factors were then inserted into the synthesis with both signs thereby obtaining a projection of the correct structure together with its mirror image. Successive applications of the least-squares method to the selected structure in order to minimize $F_o^2 - F_c^2$ improved the percentage agreement rapidly from 30 per cent to 13·7 per cent.

Comparison of the *x*-co-ordinates obtained from the (010) and (001) projections gave a probable error of 0·02 A. for atoms resolved in both projections. The poor resolution observed in the *c*-axis projection necessarily limits the accuracy of certain of the calculated bond-lengths and angles; but the values obtained are in good agreement with those observed in related structures (Fig. 1).

The dimensions of the amide group accord closely with those given by Corey and Pauling[4], and it is in the *trans* configuration. It shows, however, a significant departure from planarity, since the carbonyl oxygen is 0·5 A. out of the plane containing the remaining atoms of the amide group.

The glycyl-L-alanine molecules are hydrogen-bonded into continuous spirals by the water molecules, which form two hydrogen bonds of 2·77 A. and 2·62 A. with O_1 and O'_4 (Fig. 1). The angle between them is 105°. These spirals are joined laterally by other N—H . . . O and N—H . . . Cl bonds.

The Cl^- ion is surrounded by an approximately tetrahedral disposition of three terminal $—NH_3^+$ groups and a nitrogen atom in the amide group of an adjacent molecule all at distances of between 3·23 A. and 3·36 A., that is, within the required limits for hydrogen bonding. The terminal $—NH_3^+$

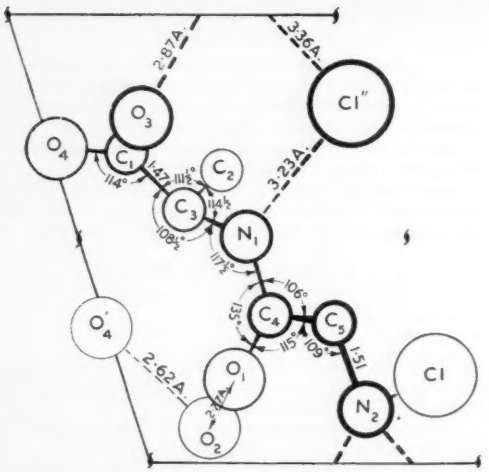

Fig. 1. Bond-lengths and -angles :

C_1O_4	1·26 A.	C_4O_1	1·21 A.	$\angle O_4C_1O_3$	123°
C_1O_3	1·24 A.	C_4C_5	1·52 A.	$\angle O_1C_4C_5$	125°
C_5N_1	1·50 A.	N_2Cl	3·18 A.	$\angle O_1O_2O'_4$	105°
C_1N_1	1·32 A.				

group, therefore, participates in the formation of three hydrogen bonds with surrounding Cl^- ions and forms a fourth N . . . H—O bond of 2·87 A. with the carboxyl group of a neighbouring molecule.

The structure conforms with Donohue's postulate[5] concerning the maximum use of the hydrogen-bonding capacities of the NH and OH groups present in the molecule for structures of this type.

A detailed account of this structure will be presented elsewhere. I am grateful to the Director and Council of the Wool Industries Research Association for permission to publish these results, and to the British Nylon Spinners, Ltd., for the facilities afforded for the completion of the work.

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A New Method for determining Ketohexoses in the Presence of Aldohexoses

A slightly modified anthrone method[1,2] has been described[3] which is suitable for the quantitative estimation of carbohydrate in chromatographic fractions. 10 ml. of a 0·02 per cent (w/v) solution of anthrone in 70 per cent (v/v) sulphuric acid is mixed with 1 ml. of the test solution, heated for 7·5 min. in a boiling water-bath and the optical density of the cooled solution read at 625 mμ against a blank. When solutions containing sucrose were analysed by this method, it was noted that, if the mixed solutions were allowed to stand before heating, there was a slow development of colour in the cold that was not apparent with solutions of aldohexoses or of oligosaccharides built up of aldohexose units. Table 1 gives a quantitative picture of the observed differences.

Table 1. Increase in the Optical Density at 625 mμ of Mixtures of Sugar Solution and Anthrone Reagent allowed to Stand at 15° C. (Coleman Universal Spectrophotometer, 1 cm. Light-Path)

Sugar	Molarity	Time elapsed after mixing (min.)		
		20	40	60
Glucose	0·02	0·01	0·01	0·02
Galactose	0·002	0·01	0·01	0·01
Mannose	0·002	0·01	0·01	0·01
Maltose	0·02	0·01	0·02	0·03
Lactose	0·002	0·01	0·01	0·01
Cellobiose	0·02	0·01	0·01	0·02
Sorbose	0·002	0·11	0·19	0·27
Fructose	0·002	0·17	0·31	0·41
Sucrose	0·002	0·17	0·31	0·45
Turanose	0·002	0·23	0·39	0·56
Raffinose	0·002	0·15	0·27	0·41
Melezitose	0·002	0·19	0·36	0·52
Xylose	0·02	0·06	0·12	0·17
Arabinose	0·002	0·01	0·01	0·02
Ribose	0·002	0·01	0·01	0·02
Rhamnose	0·02	0·12	0·18	0·23
Glucurone	0·002	0·01	0·01	0·01
Galacturonic acid	0·02	0·01	0·01	0·02
Glucosamine HCl	0·02	0·01	0·01	0·01
N-Acetylglucosamine	0·002	0·01	0·01	0·01
Heptose	0·002	0·01	0·01	0·01
Digitoxose	0·002	0·07	0·08	0·08

The temperature of the mixed reactant solutions in a 0·75-in. 'Pyrex' test-tube rose from 17° to 33° C.; but this heat of mixing was almost totally dissipated after 15 min., whereas the optical density continued to increase for periods up to 24 hr.

The blue-green colour developed by the rhamnose and pentose solutions in the cold showed a similar absorption maximum (about 625 mμ) to that from the ketose solutions. The digitoxose solutions rapidly developed a golden-brown colour with an absorption maximum at about 470 mμ, some half the final optical density being attained 1 min. after mixing. This reaction appears to be characteristic of 2-deoxy sugars, since deoxyribonucleic acid solutions slowly develop a similar colour in the cold whereas ribonucleic acid solutions do not. Moderate excess of ribonucleic acid has no influence on colour development by deoxyribonucleic acid solutions.

It is apparent that in the absence of methylpentoses, excess of pentoses (ten-fold excess of xylose over fructose gave a 40 per cent error) and large excess of aldohexoses (fifty-fold excess of glucose over fructose gave a 15 per cent error) this method

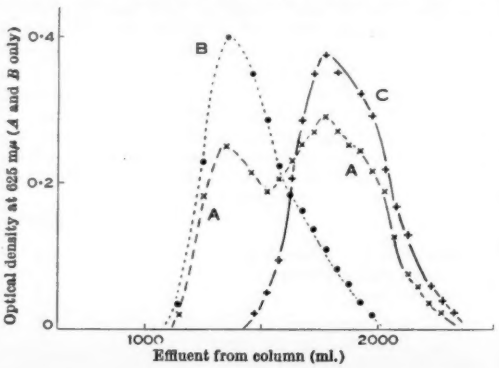

Fig. 1. Curve *A*, total carbohydrate by hot anthrone technique (fractions diluted 1 in 15). Curve *B*, ketose by cold anthrone technique (undiluted fractions, 20 min. standing). Curve *C*, reducing sugar (ref. 4)

may be used for giving a quantitative estimate of ketohexoses and their derivatives. Optical density at 625 mμ is proportional to ketose concentration in the range 0·001–0·003 *M*. The method is less sensitive than the estimation of total carbohydrate by heating, but in the system investigated (elution of sugars from charcoal columns) the concentration of sugars in the fractions was sufficient to give satisfactory results. Fig. 1 shows the application of the method to the incompletely resolved peaks of sucrose and lactose eluted from a charcoal column.

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Enzymatic Identification of the Anthocyanin Pigment of Blackberry

Karrer and Pieper reported in 1930 that the principal pigment of blackberry, *Rubus fructicosus* L., was either identical or isomeric with chrysanthemin or cyanidin-3-β-monoglucoside[1]. They obtained compact polyhedral rhombs of a' pigment chloride which was indistinguishable in colour properties from an authentic sample of chrysanthemin chloride, and differed from it only in respect of crystal form. Natural chrysanthemin chloride from *Chrysanthemum indicum* L.[2], and the chloride of synthetic cyanidin-3-β-monoglucoside[3] were known to crystallize in diamond-shaped leaflets. It was suggested that the observed difference might be due to traces of impurity in the product from blackberry[1]. Afterwards, blackberry was shown to contain a second unidentified anthocyanin by paper chromatography[4]. More recently, I have isolated from blackberry[5] a crystalline anthocyanin chloride, essentially free from the second minor component. The product was obtained in leaflets, and appeared to bear a reasonable resemblance to the crystals of chrysanthemin chloride shown in a published microphotograph[2]. However, an air-dried sample of this material was analysed correctly as a monohydrate[5], while chrysanthemin chloride crystals had previously been found to contain 1½ moles of water of crystallization[2,3]. No analysis for an air-dried sample was provided by Karrer and Pieper[1].

The data available[1,5] indicate conclusively that the anthocyanin from blackberry is a cyanidin-3-monoglucoside. Its identity with chrysanthemin would require that it be a β-glucoside. Confirmation on this point, however, appeared desirable in the light of results acquired in a study on the decolorization of berry fruit anthocyanins by fungal enzymes. It was found that the process involved, first, an enzymatic hydrolysis of the anthocyanin to anthocyanidin and sugar, and secondly, a spontaneous conversion of the aglucone into colourless derivatives[5]. Thus, if the blackberry pigment were actually a β-glucoside, the classical β-glucosidase of almond emulsin, which is capable of hydrolysing a variety of phenolic β-glucosides[6], would be expected to be an effective decolorizing agent. Emulsin, nevertheless, was found to have no measurable decolorizing action on blackberry anthocyanin.

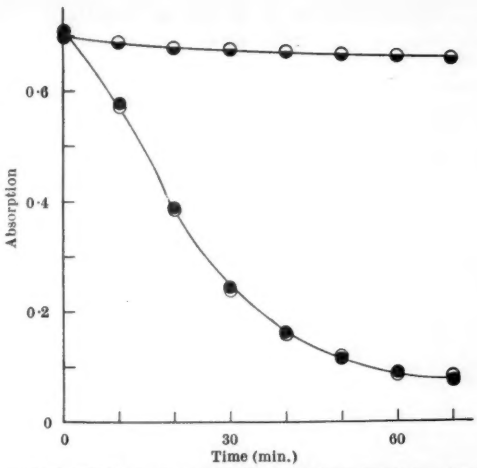

Fig. 1. Effect of anthocyanase *CN* 558 and emulsin β-glucosidase on blackberry anthocyanin and synthetic chrysanthemin. Each optically calibrated tube contained 1·10 μmole pigment and enzyme in 5 ml. of 0·045 *M* sodium lactate buffer at *p*H 3·95. The tubes were incubated at 30° C. and readings of the absorption at 510 mμ made at intervals as indicated. ○, Synthetic chrysanthemin and 1 mgm. of *CN* 558; ●, blackberry anthocyanin and 1 mgm. of *CN* 558; ◒, either pigment and 1 mgm. emulsin. Under the same conditions of enzyme, substrate and buffer concentration, hydrolysis of salicin by emulsin was 42 per cent in 60 min.

It was possible to resolve the nature of this apparent discrepancy when a specimen of synthetic cyanidin-3-β-monoglucoside chloride became available. Equimolar quantities of the synthetic pigment and the blackberry product were each subjected to the action of anthocyanase *CN* 558 and of almond emulsin respectively. Both samples were dried at 50° C. *in vacuo* for 24 hr., and used in the anhydrous state. The enzyme preparations and experimental conditions were the same as those described previously[5]. The results are summarized in Fig. 1. The curves for the decolorization of the natural and synthetic pigments by *CN* 558 are evidently identical. They demonstrate conclusively, therefore, that the blackberry anthocyanin is chrysanthemin. Differences in crystal form and amount of water of crystallization noted earlier are consequently of minor importance. Furthermore, Fig. 1 shows that neither sample is attacked by emulsin. Lack of hydrolysis is accordingly a manifestation of the inherent specificity of emulsin β-glucosidase, and need not be taken as indicating the possibility that the glucosidic linkages in the substrates might be in the α-configuration.

I thank Sir Robert Robinson for the gift of a sample of synthetic chrysanthemin chloride.

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Blood Groups of Brazilian Indians (Carajás)

The Carajás Indians of Bananal Island, found by Golden[1] to include 51 per cent of persons of group *B*, are exceptional among South American Indians, who all belong to group *O*. The late Dr. E. M. da Silva died while working among the Carajás. He found the following distribution, in 113 of them :

$$O = 104\,;\quad A = 1\,;\quad B = 3\,;\quad AB = 5.$$

Such an incidence is impossible ; but it shows that the Carajás do not possess a high percentage of group *B*. Golden, as well as da Silva, used slide methods, which are not suitable for testing anæmic people. Last July one of us (P. C. J.) went to the Carajás village and bled sixty-six Indians. The tests were made in our laboratory in Rio de Janeiro for the following blood-group systems: *ABO*, *Rh-Hr*, *MNS*, *P*, *Kell*, *Duffy*, *Lutheran* and *Lewis*. The complete results will be published elsewhere, after we have tested larger numbers of people ; but two points are of special interest. The first is that all sixty-six Indians tested with anti-*A*, anti-*B* and anti-*AB* sera, by the minimum volume technique, belonged to group *O*. Using slide tests, we obtained doubtful results with the same bloods. This probably accounts for Golden and da Silva's results. The second point is related to the *Duffy* system : among fifty-five Indians we found twenty-three *Duffy* positives. This observation seems important, since it is contrary to the results of Pantin and Junqueira[2] among other Brazilian Indians, and it indicates a lower incidence than those obtained by Pantin and Kallsen[3], and several others working on North American Indians.

This work was made possible by the co-operation of the Serviço de Proteção aos Indios and the Brazilian Air Force, to which we are very grateful. We should like to thank Hetty Brendel, nurse at Bananal Island, for help in examining the Indians.

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The *Diego* Blood Factor

In 1953 a new low-incidence blood factor, *Diego* or *Di*^{a}, responsible for hæmolytic disease, was described with the aid of an antibody produced by a mother living in Caracas, Venezuela[1,2]. The antibody, anti-*Di*^{a}, reacted with the blood of the affected child (propositus) and two of the three siblings of generation IV. The blood factor was also present in the father and three of his six siblings of generation III. The factor was transmitted to them by the paternal grandmother (generation II) of the propositus, who received it from her mother of generation I. The factor was present in the blood of nine out of twenty-nine members of the Diego family tested.

The antibody reacted only in the indirect anti-globulin test to a titre of 1 : 512. Anti-*Di*^{a} failed to react with the red cells of a thousand group *O* individuals living in the United States—mainly caucasoids.

Study of the antigens for *Di*^{a}, *ABO*, *MNSs*, *Rh*, *Kk*, *Fy*^{a}, *Jk*^{a}, *Le*^{a} and *P* in this family failed to reveal obvious linkage. Nor was there any linkage to the sex chromosome.

More recently, it became possible to demonstrate that *Di*^{a} was serologically independent of seven other low-incidence blood factors (*Mi*^{a}, *Ven*, *Ca*, *Be*^{a}, *Wr*^{a}, *By*^{a}, *Rm*) among the twelve listed by Hart, Bosman and Van Loghem[3]. (Levine and Robinson demonstrated duplication in the list of the Dutch investigators because *V*^{w} was shown to be identical with *Mi*^{a} (Miltenberger).) The factor was also independent of the following : *C*^{w}, *C*^{x}, *E*^{w}, *He* and *V*. Nor was there any demonstrable serological or genetical relationship to such high-incidence blood factors as *H* (for group *O*), *U*, *Vel* or *Tj*^{a}. These facts could be established in tests with the rare essential antibodies and selected test cells preserved in the frozen state.

In the course of the studies of the four generations of the Diego family, it was observed by Layrisse and Arends that some of them showed physical features indicative of admixture with native Indians. Accordingly, studies were carried out on caucasoids and Indians living in Venezuela[4]. The results of their tests on the Venezuelan Indians have been briefly discussed by Layrisse, M., and Arends, T. ("A High Incidence Blood-Group found in Venezuelan Indians" (in the press)). These findings, including those with the thousand caucasoids of the United States and forty-eight Indians of Brazil[5], are presented in Table 1.

Table 1. Incidence of *Dia*

Population tested	No. tested	No. positive	Per cent positive
Caucasoid, United States	1,000	0	0
Random, Caracas	266	6	2·3
Random, Barcelona, Venezuela	61	2	3·3
Caribe Indians—Cachama	121	43	35·5
Arawaco Indians	152	8	5·3
Mixed Negroes, Venezuela	150	11	7·3
Kaingangues Indians, Brazil	48	26	54·2

The studies with Venezuelan population were made by Layrisse, Arends and Sisco[4]. The anti-*Dia* serum for the study of the Brazilian Indians was made available to Fernandez *et al.*[5] by Dr. Layrisse.

Among the forty-nine individuals in the Aribe group of the Caribe Indians, there were two large families many of whom were *Di*^{a}-negative, and Layrisse *et al.*[4] offer this as an explanation for the lower incidence of *Di*^{a} as compared to that of the Cachama group. Among the 170 members of both groups all but one were in group *O* and all were *Rh*-positive.

The occurrence of the blood factor in caucasoids of Venezuela is apparently indicative of admixture with native Indians characterized by a high incidence of the blood factor. *Di*^{a} may not be completely absent in the caucasoid population free from admixture with Indians, since a second example of anti-*Di*^{a} was recently found in the serum of a mother of an infant with hæmolytic disease (Levine, P., and Stroup, M., unpublished observations). The specimens, submitted to the Ortho Research Foundation by Witebsky and Rosamilia, were derived from a Polish family living in New York State, and there is no

reason to suspect an Indian origin for the blood factor shown to be present in the father's blood and also present in the affected infant's coated red blood cells.

These findings indicate that a factor of extremely low incidence in a general population may have a much higher incidence in other population groups. To a lesser degree this applies also to other blood factors, such as the well-established differences in incidence of type Rh_0 in caucasoids and African negroes. The point at issue here is the usefulness of the term 'low incidence' to characterize certain blood factors. 'Low incidence' is preferable to 'family' or 'private', and the term is still helpful because it characterizes the first observations made with a particular blood factor.

Most significant is the occurrence of a high incidence of matings incompatible for a particular blood factor capable of causing hæmolytic disease in a population which is almost exclusively *Rh*-positive[4]. It can be safely predicted that, in the Caribe Indians or in any population with a high incidence of incompatible matings for Di^a, this factor may play a part in causing hæmolytic disease comparable in importance to the $D(Rh_0)$ factor in caucasoids provided that the two factors have the same degree of antigenicity.

If the genetically related Di^b and anti-Di^b exist, the antibody should be sought among the homozygotes of genotype Di^aDi^a of the Caribe Indians.

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The *Diego* Blood Factor in Brazilian Indians

IT has been pointed out[1] that what appears to be a rare, private or family antigen in one population may be fairly frequent in another. For example, the antigen which had sensitized an Amerindian woman so that she lost the child of her ninth pregnancy through erythroblastosis was found in the blood of her husband and of some of her children, but not in the blood of 794 other Amerindians, and it was therefore considered to be rare. However, when tested with the blood of Caucasians, the antibody could be shown just to be anti-*Kell*, the *Kell* factor being quite frequent in the Caucasian sample.

An analogous situation also involving Amerindians and Caucasians is provided by the *Diego* factor recently described by Levine, Koch, McGee and Hill[2]. This factor, discovered to be the cause of an erythroblastosis case in a Venezuelan family, was first considered to be rare because two hundred whites tested in the United States were all negative. However, Layrisse, Arends and Sisco[3], testing 266 people from Caracas and 61 from Barcelona (Venezuela), found 6 (2·3 per cent) and 2 (3·3 per cent), respectively, to be *Diego*-positive, and they ascribed this finding to Indian admixture. Testing two groups of Caribe Indians—121 in Cachama and 49 in Santa Clara of Aribi—they found 43 (35·6 per cent) *Diego*-positives in the first group and 7 (14·3 per cent) in the second. In addition, 8 (5·3 per cent) *Diego*-positives were found among 152 Guajires Indians belonging to the Arawco group.

We had the opportunity of testing two groups of Brazilian Indians with the anti-*Diego* serum using the anti-globulin method. The first group of 48 Kaingángues, living in a reservation near Palmas, State of Parana, included 22 (46 per cent) which gave a positive reaction. The second group consisted of 36 Carajás living at Santa Isabel, Bananal Island, among whom 13 *Diego*-positives (36 per cent) were found. Both groups of Indians belong to the linguistic family of the Ge and live some 1,100 miles apart.

If the *Diego* factor, as at present seems possible, is universally common among Amerindians and absent or mostly absent among whites, it might provide some indication of the degree of Amerindian admixture in many American populations. Studies of its infiltration and of the resulting antigenic incompatibility might also be rewarding.

Thanks are due to Dr. M. Layrisse for a gift of anti-*Diego* serum and to Dr. J. Dausset for its transport.

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Absence of Abnormal Hæmoglobins in some Australian Aboriginals

WHEN the sickle cell trait was found to be present in a number of Veddoid communities of southern India[1], it was also found that their rhesus chromosome distribution showed features differing from those of other Indian populations, and that it was more like those found in South-East Asia, Australasia, and especially in the Australian aboriginals. We therefore examined seventy-two Australian aboriginals for the presence of the sickle cell trait, but found that none of them showed this abnormality[2]. Since then, other abnormal hæmoglobins besides the sickle cell hæmo-

globin have been discovered. One of them, hæmoglobin *E*, was found in the Veddas of Ceylon[2], and while the presence of sickling was confirmed in those Veddoid populations of India in whom it had been originally described, several other Veddoid populations[4]—including the Veddas themselves[3]—were found to be free from sickling. We decided, therefore, to examine once more Australian aboriginals, this time for the presence of hæmoglobin *E*.

We collected blood from a hundred and sixty-six aboriginals in Queensland; a hundred and forty-eight were of unmixed Australian ancestry according to their own accounts and also to their appearances. Of the others, seventeen had some European, one some Indian, and one some Chinese forbears. The bloods of fifty-five were collected on a visit to the Mona-Mona Mission, of fifty-five from a mission near Daintree, and of fifty-six from one near Yarrabah. The blood was taken under sterile conditions and arrangements were made for speedy transport with cooling on the way, so that the specimens were examined in London less than ten days after they had been obtained in Australia. All bloods were submitted to filter-paper electrophoresis. A barbitone buffer of *p*H 8·6 and of ionic strength 0·05 was used. All hæmoglobins moved as a single band in the position of normal adult hæmoglobin controls. Hence not only did these Australian aboriginals not carry hæmoglobin *E*, but also the presence of all other known abnormal variants of adult hæmoglobin could be excluded as well.

It is still too early to assess the extent to which the distribution of sickle cell hæmoglobin and of malarial infection are related[5]. It would be even more premature to speculate on the correlation of the distribution of malaria with that of other hæmoglobins such as *E*. Nevertheless, it is noteworthy that malaria is thought to be a recent importation into the Australian mainland, and that its aboriginals, unlike most of the older populations of tropical Africa and Asia, do not seem to possess multiple hæmoglobins.

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Stability of Iso-alleles

The high stability of most genes when kept under natural conditions is deduced from the relative rarity of spontaneous mutations which produce striking deviations from normality. The existence of wild-type iso-alleles, that is, of different alleles usually causing the same normal phenotype although distinguishable by their effects under special conditions, raises the question whether mutations from one iso-allele to another are more frequent than mutations with more obvious new effects.

In order to obtain relevant data, males of a wild-type ('Canton-*S*') stock of *Drosophila melanogaster*, which had been made isogenic some time before the experiments, were crossed to homozygous *ci* ey^R females (*ci* = cubitus interruptus, ey^R = eyeless-Russian; both located in chromosome 4). The resulting F_1 *ci* $ey^R/+$ + individuals were expected to have uninterrupted fourth veins in their wings, since the Canton wild-type allele, $+^C$, is dominant over the *ci* allele. In case a mutation had occurred, from $+^C$ to an iso-allele of the type of $+^s$ which has reduced dominance[1], the appearance of interruptions on the wings would have been expected, the frequency of this event being dependent on the penetrance of the new '$ci/+^x$' genotype. Similarly, iso-alleles of *ci* might have been expected which would give vein interruptions in a new genotype '$ci^y/+^C$'.

More than 31,000 F_1 flies were raised, partly at 26° C. and partly at 18° C., the lower temperature providing a more sensitive environment in view of the known increasing penetrance and expressivity of the *ci* phenotype with decreasing temperature. Most of the F_1 flies had normal venation, but five females and fifteen males had the very weak *ci* or *ci*-like phenotype of class 1 [2], characterized by localized thinning of the cubital vein (Table 1).

Table 1. F_1 from *ci* ey^R/ci ey^R × Canton ♂♂

	Normal		*ci*-like	
Temp.	♀♀	♂♂	♀♀	♂♂
26°	9,745	9,236	2	8
18°	6,669	5,392	3	7

Seventeen of these twenty possibly mutant flies were individually tested in crosses to flies homozygous or heterozygous for *ci* ey^R. (The other three individuals left no progeny.) Sixteen of the seventeen flies did not produce any further non-eyeless *ci*-type offspring. The deviant parents had apparently unchanged *ci* $ey^R/+^C$ + genotypes, and their *ci* or *ci*-like phenotype was simply an expression of rare penetrance of *ci* in $ci/+^C$ heterozygotes. The seventeenth individual, a female, proved to have been heterozygous for a new recessive mutant allele similar to the *ci* mutant employed in these crosses but with peculiarities in expression of its own, notably frequent interruptions in the inter-crossvein section of the fourth vein. This new *ci* mutant had arisen from the $+^C$ allele.

There is thus no evidence among some 31,000 tested gametes for mutation from $+^C$ to a recognizable wild-type iso-allele, or from *ci* to a recognizable mutant iso-allele, in contrast to the finding of a typically deviant *ci* mutant from $+^C$. It must be added, however, that at the temperatures used, incomplete penetrance could have kept a considerable fraction of wild-type iso-alleles from phenotypic expression.

A priori, no close relation between type of effect and frequency of mutation should exist. The limited experiments reported here agree with this expectation.

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Bulinus (*Pyrgophysa*) *forskalii* (Ehrenberg) as a Vector of *Schistosoma haematobium*

In a recent communication, McCullough[1] stated that although the snail *Bulinus* (*Pyrgophysa*) *forskalii* was known to be a vector of urinary bilharzia in the Gambia and in Mauritius, there was no direct evidence that it acted in a similar capacity in the Gold Coast; moreover, snails of that species collected in the Gold Coast were wholly resistant to experimental attempts to infect them with the miracidia of the causative organism, *Schistosoma haematobium*.

It seems appropriate to try to throw light on some aspects of this recurrent problem. First, no laboratory infection experiments can ever show beyond doubt that a species of snail is or is not a vector of a certain schistosome. Only by the finding of 'wild' snails shedding cercariæ and the infection of definitive hosts by those cercariæ, with the subsequent recovery and identification of the adult worms, can the role of a mollusc vector be established. Secondly, the apparent difference in receptivity to infection of a snail species in different countries can only be analysed when the identity of the snails is established beyond doubt. McCullough quotes his own work in collaboration with Duke[2] in the Gambia and that of Adams[3] and Cowper[4] in Mauritius to show that *B. forskalii* is a vector in those areas. In the first case, the evidence is largely epidemiological; but in the second, successful infection experiments were carried out. McCullough admits the possibility of separate and distinct species of snails being involved in the Gambia, Mauritius and the Gold Coast; but he maintains that if this is so, the differences between them have not been recognized.

So far as the Gambia is concerned, Smithers (in the press) has shown that the vector identified by McCullough and Duke as *B. forskalii* is in fact a different species which was identified by Mandahl-Barth as *B. senegalensis* Müller. My own observations (Wright, in the press) confirm the conclusion that the vector in the Gambia is a species distinct from *B. forskalii*; but I tentatively identify it with *B. ludovicianus* (Mittre). It is only by further taxonomic work, which is now in progress, that this difference of opinion can be resolved; but there can be no reasonable doubt that the important vector in the Gambia is not *B. forskalii* (which also occurs in that area) but another *Bulinus* which can be differentiated from it on both morphological and ecological grounds.

The evidence of Adams and Cowper from Mauritius rests also on an incorrect identification of the molluscan host. Specimens of Adams's material in the collection of the British Museum have been compared with the type series of *Bulinus cernicus* (Morelet), and there is no doubt that it is to this species that the Mauritian vector should be assigned. Adams states that his snails were identified by Connolly, who used the work of Germain[5], and it is this author who is responsible for the incorrect inclusion of Morelet's species in the synonymy of *B. forskalii*.

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Initial Absorption of Ions by Plant Tissue

Recent papers have stressed two aspects of the initial entry of ions into plant cells and tissue, namely, diffusion[1,2] and ion exchange[3,4]. It is important to realize that these processes are merely two aspects of the one system. Since the unity of the experimental facts may not be obvious, it is thought necessary to review some of the evidence, and to attempt to produce agreement amid apparent contradictions.

A proportion, depending on the medium concentration, *p*H, etc., of a piece of plant tissue is penetrated by both ions of a salt, such as potassium chloride, reversibly, in 20–40 min.[1,5]. The time depends on the geometry of the system[2,5]. The proportion of the tissue which appears to reach the external concentration in the initial uptake has been termed the 'apparent free space', a term originally due to G. E. Briggs. This varies from a few to more than 30 per cent[1,2,6]. Since the initial uptake and subsequent 'accumulation' are to a large extent independent, the vacuoles, which occupy a large proportion of the tissue volume, and into which the ions are finally accumulated, are thought not to be part of the apparent free space, which therefore includes intercellular spaces, cell-wall spaces and, very probably, some cytoplasm.

The dependence of the initial uptake and apparent free space on *p*H and concentration[2] of the medium is consistent with a Donnan equilibrium between the medium and a predominantly anionic phase in the tissue. The magnitude of the free space suggests that it includes some, if not all, of the cytoplasm as well as the aqueous phase associated with those cell-wall constituents which are anionic.

The mean concentration A of the Donnan (indiffusible) anions in the free spaces has been estimated[2] to be between $0{\cdot}006\,M$ and $0{\cdot}04\,M$ in maize and bean roots, depending on the age of the tissue. From measurements of the phase-boundary potential differences, Vervelde[7] estimated the surface of the roots of barley, oats, etc., to have the equivalent of $0{\cdot}02$–$0{\cdot}06\,M$ of immobile anions at *p*H 5·5.

At external concentrations C_0 (of a single salt) comparable with or higher than A, the equilibrium concentration of mobile anions and balancing cations (C_i) in the cytoplasm is appreciable: for example, if $A = 0{\cdot}01\,M$ and $C_0 = 0{\cdot}01\,M$, $C_i = 0{\cdot}0062\,M$. In addition to this diffusion of ions of both signs when $C_0 \geqslant A$, external cations will exchange with those initially paired with the immobile anions of the free space. This effect, as can be seen from Fig. 1, becomes increasingly important in comparison with the entry of ion pairs at external concentrations less than A: for example, if $A = 0{\cdot}01\,M$ and $C_0 = 0{\cdot}001\,M$, $C_i = 0{\cdot}0001\,M$. This accounts for the conclusion by Scott Russell and Ayland[4] that diffusion in their experiments was unimportant compared with ion exchange.

In the Donnan system envisaged for the cytoplasm of the free space, cation exchange will depend on the affinity of the immobile anions (proteins and others) and the exchanging cations[4]. The specificity of binding found by Epstein has lately been referred to the ion carriers of accumulation[8] and not to the initial uptake. Exchange between anions adsorbed to cytoplasmic indiffusible cations and anions from the medium is unlikely. At *p*H 7, dissociation of the acidic groups of the surface of the protoplast is complete and cationic groups are unlikely to exist, as shown by electrophoretic studies (McLean, personal

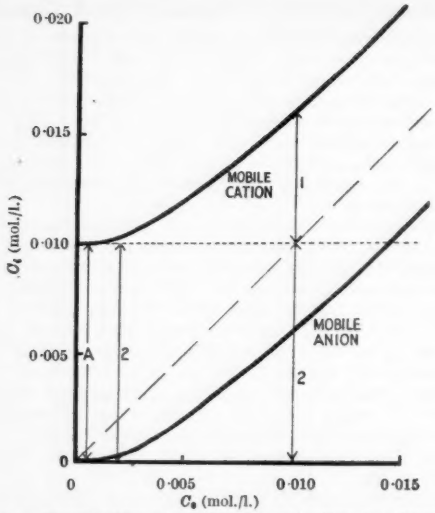

Fig. 1. Concentrations of mobile anions and cations in a Donnan phase with concentration of immobile anions $A = 0{\cdot}01$ mol./l. plotted against external concentration C_e. The dotted line represents equality of concentration. The portions 1 and 2 of the total mobile cation concentration are those diffusible and potentially exchangeable respectively

communication). In any event, the initial uptake of anions is much less than that of cations[5], consistent with a Donnan equilibrium.

The time of equilibration in the initial uptake[2], the potential-difference drifts with time when tissue encounters a new concentration[1] and the time to reach a new level of respiration on adding salt are all consistent with the absence of a high-resistance membrane at the cytoplasmic surface. Vervelde[7] also stresses the three-dimensional nature of the equilibrium.

The cation exchange and apparent free space would depend on any metabolic changes in the cytoplasm which influence the concentration of immobile ions A. Butler[6] found that 2,4-dinitrophenol increased the apparent free space of wheat roots for the chloride ion from 24 to 34 per cent. Scott Russell and Ayland[4] found a reduction of cæsium ion uptake (exchange) in the presence of dinitrophenol. Both effects may be consistent with a lowered A.

It is concluded that the hypothesis of a complex Donnan system can account for most of the observations on the initial absorption of ions by plant cells. In addition to this system, a process dependent on respiration must be postulated to explain the subsequent irreversible absorption (accumulation) probably into the vacuoles.

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Effect of Streptomycin on *Acetobacter capsulatum* and its Associated Dextran–Dextrinase Enzyme System

In an earlier publication[1], we have reported that *Acetobacter capsulatum* N.C.I.B.4943 failed to grow in a yeast extract – glucose medium containing 1 μgm. per ml. of streptomycin sulphate. More recently, we have found that *A. capsulatum* is sensitive to 1 μgm. per ml. of streptomycin sulphate at *p*H 4·5 and to 0·01 μgm. per ml. at *p*H 6·5 during 48 hr. incubation at 25° in the same medium. The effect of *p*H on antibiotic activity is already well recognized; but the extreme intolerance of *A. capsulatum* to streptomycin would seem to be unusual and worthy of note.

We have previously suggested[1] that this high sensitivity of *A. capsulatum* might be related to the fact that the organism is remarkable in its ability to convert dextrin into dextran[2], and in view of the fact that Barker, Bourne, Stacey and Ward[3] have shown that streptomycin inhibits certain carbohydrate-synthesizing and degrading enzymes, we have examined further the effect of streptomycin on *A. capsulatum* dextran–dextrinase.

Experiments have been based on the observation that there is a linear relation between relative viscosity and concentration of *A. capsulatum* dextran in 0·5 *M* acetate buffer (*p*H 4·6) between 0·0 and 1·0 mgm. per ml. At *p*H 4·6, the addition of streptomycin (1 per cent w/v) had no effect on the synthesis of dextran by the isolated enzyme[2] with a substrate concentration of 1 per cent w/v, the ratio of inhibitor to substrate being comparable to that used by Barker *et al.*[3]. Attempts to detect inhibition of the enzyme system at *p*H 6·2 failed, as no enzyme activity could be detected at this *p*H value in the absence of streptomycin. Since the enzyme is not active at the higher *p*H (the optimum *p*H for growth of *A. capsulatum*), it may be concluded that inhibition of the growth of *A. capsulatum* by streptomycin is not due to disturbance of its dextran-dextrinase enzyme system. Further, we have shown that this enzyme is extracellular, and would therefore not be expected to play a vital part in the development of the organism under normal conditions of growth. On this basis, it would appear that streptomycin affects a more fundamental metabolic process of the organism; further work is in progress.

We are grateful to Dr. T. K. Walker for his continued interest.

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Evidence for the Presence of Noradrenaline in Submicroscopic Structures of Adrenergic Axons

The presence of sympathomimetic activity in adrenergic nerve tissue has been demonstrated by several authors[1]. The active substance later was shown to possess the characteristic biological and chemical properties of noradrenaline[2]. A comparison of the relative contents of noradrenaline in splenic nerves (10–20 μgm. per gm.) and the spleen (2–4 μgm.

per gm.) suggests that the transmitter is accumulated in the terminal parts of the nerves. Certain substances, such as acids, detergents and digitonin, which release catechol amines from adrenal medullary cell granules[3], also release the adrenergic transmitter from a perfused organ[4]. Moreover, since the adrenergic nerves may be regarded as homologues of the adrenal medullary cells, it may be expected that their specific action substance is similarly stored.

In order to test this hypothesis, experiments have been undertaken involving catechol analysis of granular fractions of homogenized splenic nerves of the ox and splenic tissue from ox and rat. Noradrenaline was estimated biologically and its identity checked by paper chromatography. Histamine was also determined in some cases.

The nerves were cut into 2–3 mm. pieces and homogenized in 15–50 ml. 0·3 *M* sucrose in a Waring blendor for 1 min. at 40,000 r.p.m. After centrifugation in an angle centrifuge for 6 min. at 800 *g*, the upper part of the homogeneous supernatant, free from visible sediment, was again centrifuged for 60 min. at 6,800 *g* at + 12° C. The small amount of sediment was suspended in 5–7 ml. water to which 0·2 ml. of 0·5 *N* sulphuric acid was added. The results of five experiments are given in Table 1.

Table 1

No.	Total amount of noradrenaline (μgm./gm. nerve)	Per cent of total noradrenaline activity in sediment	Total amount of histamine (μgm./gm. nerve)	Per cent of total histamine activity in sediment
N 1	—	19	—	—
N 2	—	19	—	—
N 3	—	18	—	< 2
N 4	9·1	17	82	< 2
N 5	8·8	15	105	< 2

Of the total activity found in the supernatant after the first separation, 15–19 per cent was present in the sediment after the second centrifugation as seen in Table 1. The sediment contained only very fine granules, less than 1 μ in diameter, but no fibre structures. No granules visible with light microscopy were found in the supernatant after the second centrifugation. The granules of the sediment apparently had a high density, since they were separated and packed well on centrifugation. The noradrenaline content of the small volume of the supernatant present in the sediment accounted for less than 10 per cent of the amount found in the granular sediment. Resuspension and washing the sediment with 0·3 *M* sucrose did not alter the results.

The total noradrenaline figures of the nerve homogenate were determined in two cases and found to be 8·8 and 9·1 μgm./gm., which agrees with previous estimations[2]. Secondary adsorption of noradrenaline on the granular sediment seems unlikely, since sediment obtained in the same way from liver did not take up noradrenaline from a 0·3 *M* sucrose solution.

In two experiments the histamine content of the supernatant and the sediment was also estimated. The total amount in the homogenate was 82 and 105 μgm./gm., in agreement with previous findings[5]. Of this, less than 2 per cent was found in the sediment, which is evidence against histamine being a constituent of the same granular fraction as contains noradrenaline.

In nine experiments the noradrenaline content was determined in the corresponding fractions of ox spleen homogenized by the Potter–Elvehjem method. The homogeneous supernatant was recentrifuged once or twice. The sediment contained 16–44 per cent of the total activity, on an average 32 per cent. Similar results were obtained in five experiments with rat spleen (14–29 per cent, average 23 per cent).

While the experiments reported here have demonstrated the presence of noradrenaline in a readily sedimentable granular fraction from adrenergic nerves, analogous to the form of storage found in the chromaffin cell, detailed statements as to the nature of these particles must await further experiments. Histamine, although present in large amounts in the adrenergic nerves of the ox, is not present in these structures.

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Simultaneous Recording of Inspired Oxygen Concentration and Peripheral Tissue Oxygenation

It is often of great convenience in physiological work to secure continuous rather than intermittent records of the variables under investigation. Recently an apparatus was described for analysing continuously the gas mixture presented to infants undergoing treatment in nursery incubators[1], and an extension of this principle has now been used in some animal experiments with the view of examining the response of the organism to changes in oxygen content of its inspired air. By a combination of such records it should be possible to derive an estimate of the minimal change in inspired oxygen which will produce a significant change in the peripheral tissues of the animal or infant.

The method employed for measuring oxygen tension in the tissues is a development of the polarographic techniques introduced by Davies and Brink[2], and afterwards extended by Montgomery and his co-workers at the University of Philadelphia[3]. The electrodes used are a cathode of 0·005 in. diameter platinum wire, insulated except for a length of about 0·5 mm. near the tip with 'Diamel' enamel, and a non-polarizable anode of 0·01 in. diameter silver wire electrolytically coated with silver chloride[4]. (When suitably applied, 'Diamel' enamel gives a tough yet flexible high-resistance insulating coating to the wire.) These electrodes were inserted through truncated hypodermic needles for a distance of about 2 mm. through the skin of a rabbit's back. The points of insertion were coated with collodion, and the area covered with transparent plastic tape. The rabbit, anæsthetized with 'Nembutal', was placed

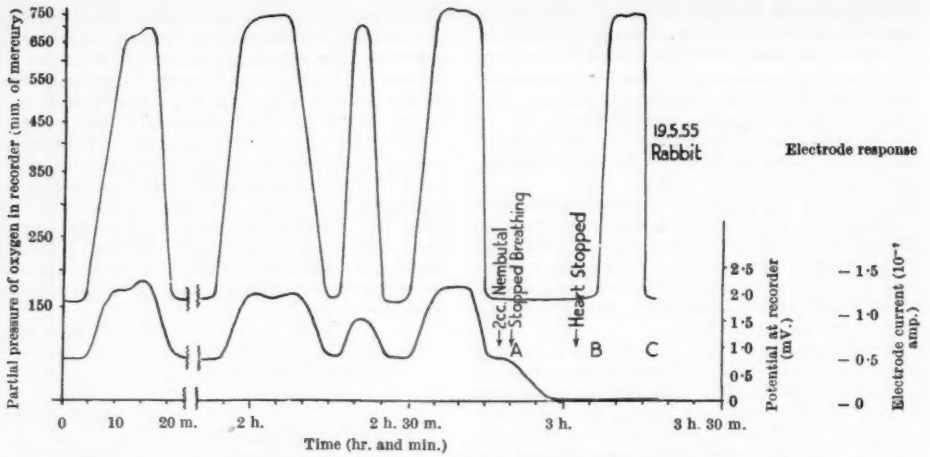

Fig. 1. Upper curve: oxygen partial pressure in the chamber: recorded by the magnetic oxygen meter. Lower curve: simultaneously recorded subcutaneous oxygen-electrode currents

in a closed chamber into which varying mixtures of oxygen and air could be admitted from gas cylinders. The oxygen content of the gas in the respiration chamber was recorded by means of a magnetic instrument, based on that of Naumann[5] but designed to record continuously from zero to 100 per cent oxygen concentration at or near atmospheric pressure (Kay, R. H., and Hobson, A., unpublished). Simultaneously, the polarographic current passing between the electrodes when an e.m.f. of 0·6 V. was maintained across them was amplified and recorded. The final display was an Elliott six-channel potentiometer recorder, inspired-oxygen concentration being fed to the even-numbered channels, polarographic electrode currents to the odd. Fig. 1 shows a record obtained in a typical experiment.

It was necessary to be sure that the oxygen tension registered by the electrodes was determined by the circulation and not by diffusion across the skin of the rabbit. This is shown by the last portion of the curves in Fig. 1 where, on abolishing the rabbit's respiration by a large additional dose of barbiturate, it was possible to observe a fall in electrode current to zero when the rabbit was exposed to air (*A*), while a subsequent exposure to pure oxygen produced no rise in the tissue tension (*BC*).

To summarize briefly the results of these preliminary experiments, which were carried out at room temperature: (1) when the oxygen content of the inspired gas is varied cyclically between 21 per cent and 100 per cent (as in Fig. 1), the recorded tissue electrode current begins to rise or fall within one minute of the beginning of the rise or fall of concentration of the inspired oxygen. (2) The initial rate of change of both tissue-electrode current and concentration of inspired oxygen are usually closely similar, provided the latter does not change more rapidly than 1 min. to half-total change. (3) There is evidence that a rapid reduction (from 100 per cent) of inspired oxygen concentration is more quickly reflected in the tissue response than is a similarly rapid increase (from 21 per cent) of concentration of inspired oxygen.

The amplitude of the tissue-current response, corresponding to the five-to-one change in concentration of inspired oxygen, is usually of the order of three to one. This order of magnitude corresponds well with intermittent tissue-tension measurements by subcutaneous gas depots in animals[6].

Although it is extremely difficult to calibrate the electrode current in terms of absolute oxygen tension in the tissues (this is easy *in vitro*), nevertheless there is good reason for supposing that the changes recorded reflect the ratio of oxygen tensions under different conditions quantitatively.

Similar records have been obtained from monkeys with electrodes in the back and scalp, and it is proposed to use this technique on human subjects in order to study their response to inhaled oxygen. The method is now repeatable and safe. Detailed results will be published later.

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Autoradiographic Localization and Measurement of Intracellular Antibody, using Labelled Antigen

Following on work in which much indirect evidence implicated the plasma-cell as the site of antibody production[1], microscopic demonstration of antibody in plasma-cells was effected by a fluorescein-conjugate technique[2]. However, this method is limited to some extent by the difficulty in studying the morphology of antibody-containing cells, by the possibility of non-specific staining and by its inability to yield quantitative results. Further, since

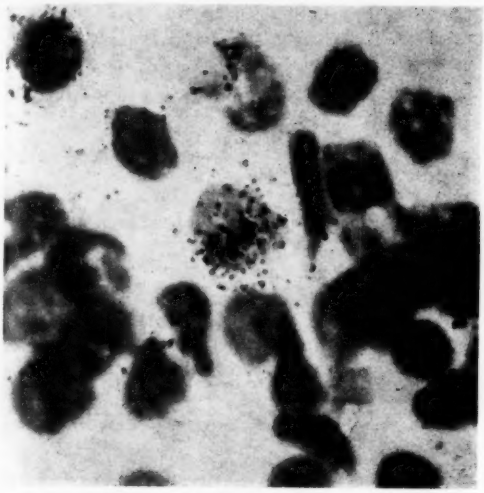

Fig. 1. Imprint of spleen showing fixation of labelled polysaccharide by certain cells. Kodak autoradiographic stripping film. Exposure 40 days. Stained with Leishman–Giemsa

this technique renders both antibody and antigen in tissues fluorescent, it would be difficult to exclude the presence of a small amount of antibody in the neighbourhood of persisting injected antigen.

In the present investigation, rabbits were immunized with a formalin-killed culture of a *Klebsiella*. Touch-preparations of spleen and lung on slides were fixed in 95 per cent ethanol at 37° C. for 30 min. The same organism was grown in a synthetic medium with sodium acetate - 1 - ^{14}C as the sole source of carbon. The polysaccharides were extracted[3] and had a specific activity of about 1 μc. per mgm. (kindly determined by Dr. A. S. McFarlane).

The touch-preparations were covered with labelled polysaccharide (0·1 mgm./ml. in saline) for 1–2 hr. at room temperature, and uncombined material washed off. Autoradiographs were made, with exposures of 30–40 days, and the preparations stained[4].

Radioactivity due to fixation of polysaccharide showed the presence of antibody in a proportion of cells. No evidence of radioactivity was seen over the many reticulo-endothelial cells present.

The number of silver grains over individual cells was counted and, since the specific activity of the polysaccharide was known, this enabled the amount of polysaccharide deposited per cell to be estimated.

From a sample of the serum of one rabbit, 1 mgm. of polysaccharide precipitated 4·2 mgm. of antibody. When the serum was dried, fixed in ethanol and redried in the same way as were the tissue preparations, the antibody suffered an eight-fold reduction in combining power. Accordingly, the amount of antibody per cell was calculated by multiplying the amount of polysaccharide deposited by 4·2 × 8. The result varied from 5 to 50 μgm. per cell. This would correspond to about 3–33 per cent of the protein of a cell of 1,000 μ³ volume.

Although, owing to initially inadequate touch-preparation technique, the morphology of the antibody-containing cells is not clear, this method offers the possibility of correlating antibody content with cell morphology and with the level of circulating antibody. The production, storage and release of antibody may thus be studied quantitatively, and on a cytological level. The method may also be applied to the study of allergic states.

I am indebted to Dr. H. Loewenthal for continued interest and for the provision of facilities.

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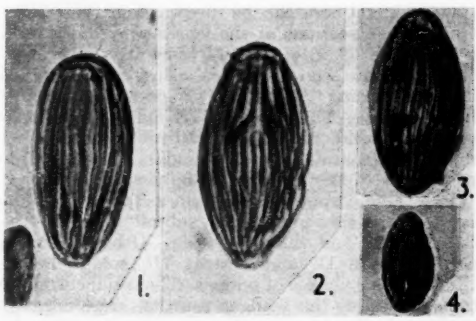
Pollen Grains of the *Ephedra* Type in Australian Tertiary Deposits

Pollen grains with the same shape, approximate size-range and exine characters as those of *Ephedra* and *Welwitschia* have been found recently in certain Lower Tertiary deposits in south-eastern Australia. The pollen grains of *Ephedra* and *Welwitschia*[1] are characterized by the more or less prominent longitudinal ridges into which the exine is raised, and the structureless nature of the exine itself; but, whereas those of *Welwitschia* have a distinct germinal furrow, the pollen grains of most species of *Ephedra* have no furrow. The absence of a furrow from the Australian fossil pollen grains in question suggests that they are more closely related to *Ephedra* than to *Welwitschia*.

In the southern hemisphere the living species of *Ephedra* are restricted to South America, where they are most abundant in the Andes region of Bolivia and Paraguay; they also extend southward to Chile and Patagonia. The occurrence of pollen grains of the *Ephedra* type in Australian Lower Tertiary deposits, therefore, indicates that *Ephedra* was more widely distributed in the southern hemisphere during early Tertiary times than it is at present.

Fossil pollen grains of the *Ephedra* type have been recorded from: Post-glacial deposits and other sediments in Tierra del Fuego and Patagonia[2]; the Eocene Green River oil shales, United States[3]; Paleocene deposits in the Province of Hanover[4];



(1) Acetolysed pollen grain of *Ephedra nana*. × *c.* 600. (2)–(4). Pollen grains of the *Ephedra* type from Australian Tertiary sediments. × *c.* 600

Cretaceous deposits in Iraq, Nigeria and Venezuela[5]; and an Upper Eocene deposit in the United States[6].

The Australian pollen grains of the *Ephedra* type have been found in sediments situated near Launceston, Tasmania, near Nelson, Victoria, and near Lake Frome, South Australia, that range in age from Paleocene to Eocene. Their occurrence in these sediments is extremely sparse.

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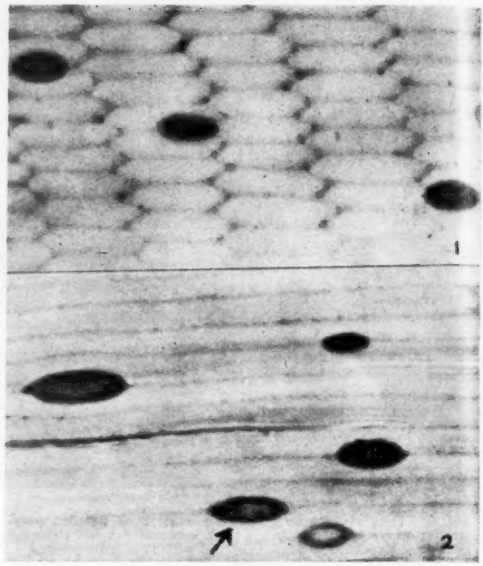
Lipide (Sudan Black Positive) Corpuscles in the Bovine Lens

During the course of histochemical investigations on lipides in the adult bovine lens, I observed certain sudanophilic corpuscles which do not appear to have been previously described. These bodies were discovered because of their intense staining with sudan black *B* (and also with its acetylated derivative[1]), which was applied to frozen sections of thin lens slices that had been fixed in calcium chloride formol immediately after death. They are to be found in a restricted zone (1 mm. or so wide in the radial direction) which lies 2–3 mm. from the lens equator and extends a few millimetres on either side of the equatorial plane.

The bodies were present in all twenty bovine lenses examined; they lie between the lens fibres and are seemingly embedded in the cement substance, which also stains with sudan black. In equatorial sections they are found along the broad sides of the unequal hexagons which are characteristic for cross-sections of the lens fibres in this zone (Fig. 1). These corpuscles possess an ovoid form which is elongated in a direction concentric with the lens nucleus, as can be deduced by comparing their appearances in equatorial and meridional sections (Figs. 1 and 2). They vary considerably in size, with a length ranging from 2 to 15μ; but the larger forms are more frequent. Prolonged staining with sudan black *B* causes many of them to become intensely, almost homogeneously, blackened. When only lightly stained (for example, for 5 min. in a saturated solution of sudan black in 70 per cent alcohol at room temperature) a dense outer rim and a paler central core can be discerned in these structures. When sections of the lenses were cut parallel to the plane of an equatorial tangent, many of the corpuscles were seen to contain a fine, often crenated, filament forming an incomplete circle in the peripheral zone. This filament is only occasionally evident in meridional (Fig. 2) and equatorial sections. Sometimes, minute, strongly sudanophilic granules are present in the interior of the corpuscle (Fig. 2).

Once these corpuscles had been located with sudan black, it was then possible to submit them to other histochemical and tinctorial tests. Other fat stains, such as sudan IV and Fettrot 7*B*, coloured these objects in pale shades of orange. The usual chromatin stains, including the Feulgen reaction, were negative. After applying the periodic acid – Schiff routine the corpuscles were faintly positive; the performic acid – Schiff technique and direct Schiff reaction were both negative.



Frozen sections of the bovine lens. Fixation in calcium chloride formol. Stained with sudan black *B*. Both × 1,500.

Fig. 1. An equatorial section illustrating sudanophilic corpuscles and their relationship to the broad sides of adjacent lens 'hexagons'. The cement substance, in which the corpuscles appear to be embedded, is also sudanophilic.

Fig. 2. A meridional section. The relationship of corpuscles to the cement material and to the lens fibres is again evident. Several corpuscles exhibit a dense rim and paler core. One corpuscle (indicated by arrow) shows the coiled filament and minute granules described in the text

The nature and significance of these corpuscles remains, at present, obscure. One is struck by the resemblance which they bear to nuclei; this resemblance, however, is superficial, for their morphology, tinctorial and histochemical properties, together with their location between the fibres and their situation in a zone lying some distance from that of the true nuclei, all point very strongly against a nuclear relationship.

In view of the notorious ease with which artefacts can occur in microscopic sections of the lens, an attempt was made to eliminate this possibility. Fresh frozen sections of material preserved by freezing (– 80° C.) immediately after death were examined with the phase-contrast microscope; the corpuscles were well seen and their relationship to the cement material again confirmed. Examination with the polarizing microscope did not reveal birefringence.

Similar corpuscles were also observed in lenses from the cat and the dog. As I have been unable to find any previous reference to these structures, I should be most grateful for comments or additional information.

A. J. Dark

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Aug. 17.

[1] Casselman, W. G. B., *Quart. J. Micr. Sci.*, **95**, 321 (1954).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, January 9

ASSOCIATION OF APPLIED BIOLOGISTS (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP, in the Large Chemistry Lecture Theatre, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 10.30 a.m. and 2.15 p.m.—Symposium on "The Resistance of Insects to Insecticides".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Efficient Use of Technical Personnel".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the FOOD GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. Rupert Carr: "Management and Food Science".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Miss Freya Stark: "Some Minor Battlefields of Alexander in Asia Minor".

Tuesday, January 10

INSTITUTION OF CHEMICAL ENGINEERS (joint meeting with the CHEMICAL ENGINEERING GROUP of the SOCIETY OF CHEMICAL INDUSTRY, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. H. F. Smith: "Explosions and Poisons—A Comparison of American and British Precautions".

ILLUMINATING ENGINEERING SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. G. T. Winch: "Recent Developments in Photometry and Colorimetry".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (joint meeting with the EDUCATION GROUP of the INSTITUTION OF MECHANICAL ENGINEERS, at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Teaching Electrical Engineering to Mechanical Engineering Students".

INSTITUTE OF METAL FINISHING, ORGANIC FINISHING GROUP (at the British Institute of Management, 8 Hill Street, London, W.1), at 6.30 p.m.—Mr. R. J. Brown and Mr. A. J. Birch: "Performance Testing of Paint Films".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Prof. W. S. Hemp: "Some Modern Structural Problems".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion Meeting on "Hopes and Aims of the International Geophysical Year". Chairman: Sir David Brunt, F.R.S. Speakers: Dr. Lloyd V. Berkner and Sir Graham Sutton, F.R.S.

ROYAL SOCIETY OF MEDICINE, PSYCHIATRY SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Prof. L. S. Penrose: "The Prospects of Genetical Research in Mental Illness"; Dr. J. Fraser Roberts: "Some Preliminary Results of Two Surveys on Mental Deficiency".

Wednesday, January 11

SOCIETY FOR APPLIED BACTERIOLOGY (joint meeting with the MICROBIOLOGY GROUP of the SOCIETY OF CHEMICAL INDUSTRY, at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 10.45 a.m.—Symposium on "Anaerobes".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Frank Dixey: "The East African Rift System".

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. D. T. Germain-Jones: "Modern Methods of Geophysical Prospecting for Oil".

ANTIQUARIAN HOROLOGICAL SOCIETY (at the Science Museum, South Kensington, London, S.W.7), at 7 p.m.—Dr. Joseph Needham, F.R.S.: "Time Measurement in Ancient and Medieval China".*

Thursday, January 12

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 424, Birkbeck College, Malet Street, London, W.C.1), at 1 p.m.—Mr. A. Crawford: "The Study of the British Road User".

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Lecture Theatre of the Royal School of Mines, Prince Consort Road, London, S.W.7), at 3.30 p.m.—Dr. H. M. Rosenberg: "The Fatigue of Metals at Low Temperatures".

ASLIB (joint meeting with the SCIENTIFIC FILM ASSOCIATION, at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Sir Arthur Elton: "The Documentation of History by Film".

ROYAL AERONAUTICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Mr. N. E. Rowe: Presidential Address.

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. B. W. Balls: "Liquid Flow Control".

Friday, January 13

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion—"Irregular Changes in the Rotation of the Earth". Chairman: Sir Harold Spencer Jones, F.R.S. Speakers: Mr. T. Gold, Dr. W. H. Munk and Prof. S. K. Runcorn.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL SCIENTIFIC OFFICER (with at least a second-class honours degree in metallurgy or physics or equivalent qualifications, and a sound knowledge of theoretical physical metallurgy) with the Industrial Group of the U.K.A.E.A., Research and Development Branch, Windscale, Sellafield, Cumberland, to lead a team engaged on the study of materials of interest associated with nuclear reactors—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting Ref. 1215 (January 10).

MATHEMATICIAN/STATISTICIAN (with an honours degree in mathematics or statistics and some experience in the analysis of experimental data) IN THE SCIENTIFIC DEPARTMENT at London H.Q., for duties which include providing advice on scientific problems, design of experiments and analysis of experimental data obtained by scientists in the coalfields and involve some travelling—National Coal Board, Staff Department (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting 88/160 (January 12).

ASSISTANT LECTURER (with an honours degree in agricultural botany or botany, and preferably some teaching experience) IN AGRICULTURAL BOTANY—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (January 14).

CHEMIST (under 35, with a degree or equivalent qualification in chemistry, and preferably with training in physics or geology) IN THE DEPARTMENT OF RESEARCH AND SPECIALIST SERVICES, Federal Ministry of Agriculture, Federation of Rhodesia and Nyasaland, for duties which include routine and research work on soil fertility and on all related agricultural products and problems, and may necessitate periods of up to six months in the field on soil surveys—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (January 14).

HOSPITAL PHYSICIST (with a first- or second-class honours degree in physics and at least five years experience in the medical field, including radiotherapy), to take charge of a laboratory engaged in experimental and routine work for the medical staff—The House Governor, King's College Hospital, London, S.E.5 (January 14).

ASSISTANT (with a degree in electrical engineering and preferably some research or industrial experience) IN THE DEPARTMENT OF ENGINEERING—The Secretary, The University, Edinburgh (January 15).

LECTURER, Grade II (graduate in mining with underground experience, and preferably with research experience) IN COAL MINING—The Registrar, The University, Edgbaston, Birmingham 15 (January 16).

PHYSICAL CHEMISTS (with a good honours degree) for work covering fundamental and applied research on coal (Ref. 88/140); and SCIENTIFIC TECHNICAL OFFICERS (with experience in physical or analytical chemistry) (Ref. 88/141)—The National Coal Board, Coal Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting appropriate 88 Ref. No. (January 17).

RESEARCH ASSISTANT (with a university honours degree, or equivalent, in botany) AT THE DEPARTMENT OF AGRICULTURE Cereal Station, Ballinacurra, Midleton, Co. Cork—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (January 17).

CHEMIST (with a good honours degree or equivalent) in the National Coal Board's Coal Survey Laboratory, Edinburgh, for analytical investigational work—The National Coal Board, Staff Department (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting 88/148 (January 21).

LECTURER OR SENIOR LECTURER IN THE DEPARTMENT OF ELECTRONIC ENGINEERING, and a LECTURER IN THE DEPARTMENT OF ELECTRIC POWER ENGINEERING—The Registrar, The University, Liverpool (January 21).

LECTURERS/SENIOR LECTURERS (2) IN GEOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 21).

LECTURER (first-class honours graduate in mathematics, and preferably with a special interest in some branch of applied mathematics or in statistics) IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (January 23).

ASSISTANT LECTURER (with an honours degree in agriculture or a pass degree in agriculture with a postgraduate diploma, or equivalent qualifications) IN AGRICULTURE—The Registrar, The University Reading (January 28).

JOHNS-MANVILLE SENIOR FELLOW IN THE CHEMISTRY DEPARTMENT, to assist in research on autoclaved Portland cement—The Secretary, Marischal College, University of Aberdeen (January 31).

LECTURER OR SENIOR LECTURER IN INORGANIC CHEMISTRY at the University of Tasmania and Hobart Technical College—The Agent General for Tasmania, 457 Strand, London, W.C.2, or The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hobart, January 31).

RESEARCH OFFICER (recent graduate) WITH THE AUSTRALIAN LEATHER RESEARCH ASSOCIATION, Lane Cove, near Sydney, New South Wales, Australia, for duties which will involve the study by chemical and physical means of the properties of tannins, other than wattle, in Australian native flora, or in exotics cultivated in Australia (principally *Pinus radiata*) with various eucalypts and mangroves as the subjects of subsidiary investigations—The Director, Australian Leather Research Association, c/o Mr. W. Ives, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (January 31).

I.C.I. RESEARCH FELLOWS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY, PHYSICS OR CHEMICAL TECHNOLOGY—The Secretary, The University, Edinburgh (February 13).

REGIUS PROFESSOR OF GEOLOGY AND MINERALOGY in the University of Edinburgh—The Private Secretary, St. Andrew's House, Edinburgh 1 (February 18).

ABSTRACTOR (with a degree, higher national certificate or equivalent, and a knowledge of languages, particularly German)—The Assistant

Secretary, Ref. B.67, British Coal Utilization Research Association, Randalls Road, Leatherhead.

Assistant Lecturer, Grade B (graduate of a British university) in Inorganic Chemistry—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

Electrical Engineer (with a first- or second-class honours degree or equivalent in electrical engineering) at the Royal Aircraft Establishment, Farnborough, Hants, to work on research in and development of radio and other fuzing techniques for guided weapons and bombs—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.580/5A/TA.

Engineers and Physicists (particularly with electronics), Senior Scientific Officer and Scientific Officer grade (with an appropriate first- or second-class honours degree or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments, chiefly in the Weymouth and Portsmouth areas and home counties—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.344/5A.

Engineers, Mathematicians and Physicists (with a first- or second-class honours degree or equivalent qualification) at the National Gas Turbine Establishment, near Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.661/5A/AA.

Professor of Chemical Engineering—The Head, Department of Chemistry, University of Saskatchewan, Saskatoon, Sask., Canada.

Scientific Officer, Physicist (with a first- or second-class honours degree in physics or mechanical engineering), to assist in a group studying the effects of vibrations and impulse stresses on weapon assemblies—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting A.703/34.

Scientific Officer (with an honours degree, preferably in engineering) for dairy engineering research, initially in connexion with machine milking—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 55/26.

Senior Biochemist (with experience in clinical chemistry or hormone assay), and a Biochemical Assistant (with some research experience) to work in a Clinical Research Laboratory—The House Governor, Royal Marsden Hospital, Fulham Road, London, S.W.3.

Senior Physics Master—The Headmaster, School House, Cranbrook, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1954. North Western Division. By G. Hoyle. Pp. ii+29+5 plates. 2*s*. net. West Midland and Southern Division. By J. E. Henshaw. Pp. ii+29+2 plates. 2*s*. net. (London: H.M. Stationery Office, 1955.) [3110

Scottish Marine Biological Association. Annual Report, 1954–55. Pp. 40. (Millport, Isle of Cumbrae: Scottish Marine Biological Association, 1955.) [111

Discovery Reports. Vol. 27. Pp. 377–395+plates 20 and 21: Cestodes of Whales and Dolphins from the Discovery Collections. By S. Markowski. (Cambridge: At the University Press, 1955. Issued by the National Institute of Oceanography.) 12*s*. 6*d*. net. [211

Hospitals and the State: Hospital Organisation and Administration Under the National Health Service. Background and Blueprint (1). Pp. iii+44. (London: Acton Society Trust, 1955.) 4*s*. [311

Department of Scientific and Industrial Research. Methods for Detection of Toxic Gases in Industry. Leaflet No. 4: Benzine Vapour. Second edition. Pp. iv+5. (London: H.M. Stationery Office, 1955.) 1*s*. net. [311

The Principles of Argon-Arc Welding Aluminium. Prepared by P. J. Houldcroft. Pp. v+18. (London: British Welding Research Association, 1955.) 2*s*. 6*d*. [311

British Electrical and Allied Industries Research Association. Technical Report L/T 316: Polarization of Dielectrics by Slow Particles. 3. By H. Pelzer. Pp. 9. (Leatherhead: British Electrical and Allied Industries Research Association, 1954.) 7*s*. 6*d*. [311

Building Research Station Digest. No. 18 (revised October 1955). Smoky Chimneys. Pp. 5. (London: H.M. Stationery Office, 1955.) 3*d*. [411

British Rayon Research Association. Report of the Director of Research for 1954–55. (8th Annual Report.) Pp. 6. (Manchester: British Rayon Research Association, 1955.) [411

Ministry of Housing and Local Government; Department of Health for Scotland. (Alkali etc., Works Regulation Act, 1906, and Alkali etc. Works Orders 1928–1950. Alkali etc. Works Regulations (Scotland) Acts, 1906 and 1951.) Ninety-first Annual Report on Alkali etc. Works by the Chief Inspectors, 1954. Pp. 84. (London: H.M. Stationery Office, 1955.) 3*s*. net. [411

Royal Greenwich Observatory. Sunspot and Geomagnetic-Storm Data derived from Greenwich Observations, 1874–1954. Compiled under the direction of Sir Harold Spencer Jones, F.R.S. Pp. viii+106. (London: H.M. Stationery Office, 1955.) 25*s*. net. [411

Forestry Abstracts. Vol. 16, No. 4 (October 1955). Abstracts 3710–4856. Compiled from World Literature. Pp. 453–598. (Farnham Royal: Commonwealth Agricultural Bureaux, 1955.) 18*s*. [411

Department of Scientific and Industrial Research. Chemical Research Laboratory. Safety Measures in Chemical Laboratories. Second edition. Pp. vi+22. (London: H.M. Stationery Office, 1955.) 1*s*. 6*d*. net. [511

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 661, Vol. 239 (3 November, 1955): The Functional Morphology of the British Ellobiidae (Gastropoda Pulmonata), with special reference to the Digestive and Reproductive Systems. By J. E. Morton. Pp. 89–160. 22*s*. 6*d*. No. 662, Vol. 239 (3 November, 1955): Studies of the Post-Glacial History of British Vegetation. 13: The Meare Pool Region of the Somerset Levels. By H. Godwin, F.R.S. Pp. 161–190. 9*s*. 6*d*. (London: Royal Society, 1955.) [611

Physics and Philosophy. By Lord Cherwell. (Being the first Robert Grosseteste Memorial Lecture delivered on 21 May 1955, in the Chapter House of Lincoln Cathedral.) Pp. 21. (London: Oxford University Press, 1955.) 2*s*. 6*d*. net. [811

Other Countries

The Diffusion Technique for the Validation of Test Items (a New Method). By Md. Firdouse Khun. (First published as an article in the *Dacca University Studies*, Vol. 7, June 1951, Nos. 1 and 2.) Pp. 8. (Pathantooly, Chittagong: Mrs. K. A. Begum, B.T., 1955.) 3 annas. [3110

Western Australia. Geological Survey. Bulletin No. 108: The Geology of the Irwin River and Eradu Districts and Surrounding Country. By W. Johnson, L. E. De La Hunty and J. S. Gleeson. Pp. 131+6 plates. (Perth: Government Printer, 1954.) [3110

Smithsonian Miscellaneous Collections. Vol. 128, No. 8: A Review of the Upper Eocene Artiodactyla of North America. By C. Lewis Gazin. Pp. iii+96+18 plates. (Publication 4127.) Vol. 131, No. 1: Leading Operations of the Smithsonian Astrophysical Observatory, 1895–1955. By C. G. Abbot. Pp. 8. (Publication 4222.) (Washington, D.C.: Smithsonian Institution, 1955.) [111

United States Department of the Interior. Geological Survey Bulletin 1015 F: Geology and Coal Resources of the Henryetta Mining District, Okmulgee County, Oklahoma. By R. J. Dunham and J. V. A. Trumbull. (A Contribution to Economic Geology.) Pp. iv+183–225+plates 21–24. (Washington, D.C.: Government Printing Office, 1955.) 1 dollar. [111

Colony of Mauritius. Annual Report of the Observatory Department for the year 1954. Pp. 1+14. (Port Louis: Government Printer, 1955.) 25 cents. [111

Development of Seed Production and the Seed Trade in Europe. (Project No. 214.) Pp. 138. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1955.) 350 francs; 7*s*.; 1 dollar. [111

United States Department of Agriculture. Circular No. 964: The California Five-Spined Engraver: Its Biology and Control. By George R. Struble and Ralph C. Hall. Pp. 21. 15 cents. Technical Bulletin No. 1121: Effects of Certain Insecticides in Soil on Crop Plants. By Victor R. Boswell, W. J. Clore, B. B. Pepper, Clifford B. Taylor, Paul M. Gilmer and Robert L. Carter. Pp. 60. 30 cents. (Washington, D.C.: Government Printing Office, 1955.) [111

New Zealand Forest Service. Information Series. No. 13: Careers in Forestry. (Revised edition.) Pp. 8. No. 21: Woodsman Training. Pp. 12. No. 22: Technical Training in Forestry. Pp. 7. (Wellington: New Zealand Forest Service, 1955.) [111

New Zealand Marine Department: Fisheries Laboratory. Fisheries Bulletin No. 11: The Escapement of Small Fishes from Trawl Nets and Its Application to the Management of the New Zealand Snapper Fisheries. By R. Morrison Cassie. Pp. 100. (Wellington: Government Printer, 1955.) [111

United States Department of Commerce. Weather Bureau. Technical Paper No. 15: Maximum Station Precipitation for 1, 2, 3, 6, 12, and 24 hours. Part 11: North Carolina. Pp. ii+81. 45 cents. Part 12: Oregon. Pp. ii+106. 55 cents. (Washington, D.C.: Government Printing Office, 1955.) [111

Southern Rhodesia. Report of the Trustees and Director of the National Museums of Southern Rhodesia for the year ended 31st December, 1954. Pp. ii+20. (Salisbury: National Museums of S. Rhodesia, 1955.) [111

East Africa High Commission. East African Tsetse and Trypanosomiasis Research and Reclamation Organization. Annual Report, 1954–55. Pp. 62+2 plates. (Nairobi: East African Tsetse and Trypanosomiasis Research and Reclamation Organization, 1955.) [211

Biological Sciences Serial Publications: a World List, 1950–1954. Prepared under the Sponsorship of the National Science Foundation by the Science Division, Reference Department, Library of Congress. Pp. viii+270. (Philadelphia: Biological Abstracts, University of Pennsylvania, 1955. Published for the Library of Congress.) 2 dollars. [211

Clinic for Psychotherapy, Melbourne. Bulletin No. 2: Aspects of Psychotherapy. By Dr. C. Kent. Pp. 1+6. Contributions to Modern Thought. No. 1: Head Sensations and the Concept of Inhibited Growth. By Dr. C. Kent. Pp. 24. Series: Our Peace of Mind. No. 3: Repetition Compulsion. By Dr. C. Kent. Pp. ii+6. No. 5: Resistance Against Psychotherapy. By Dr. C. Kent. Pain. By Jane Kamm. Accident Proneness. By Dr. C. Kent. Aggression. By Dr. C. Kent. Pp. ii+30. No. 6: Another "Jill". By Jane Kamm. Aspects of Emotional Health. By Dr. C. Kent. Alcoholism. By Dr. C. Kent. On Headaches, and the Possibility of Inhibited Growth. By Dr. C. Kent. Pp. ii+30. Bulletin No. 1: Aspects of Love. By Dr. C. Kent. Pp. 1+7. (Melbourne: Clinic for Psychotherapy, 1954 and 1955.) [411

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